NAVY-21 UPDATE

Implications of Advancing Technology for Naval Operations in the Twenty-First Century

NATIONAL RESEARCH COUNCIL

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IMPLICATIONS OF ADVANCING TECHNOLOGY FOR NAVAL OPERATIONS IN THE TWENTY-FIRST CENTURY

Naval Studies Board
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Mathematics, and Applications
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Preface

In the summer of 1988, the National Research Council issued the Naval Studies Board's report *Implications of Advancing Technology for Naval Operations in the Twenty-First Century*, known as *Navy-21* (National Academy Press, Washington, D.C.). The study had been carried out over the previous 18 months, at the U.S. Navy's request. In the terms of reference for that study, the Chief of Naval Operations (CNO) asked how future technological trends might change Navy force structure, what the impact of those changes on U.S. maritime strategy might be, and how the Soviet Union might respond. The study involved 188 civilian experts and 22 Navy and Marine Corps liaison officers. It was informally agreed when the study was completed that it represented a broad and solid base from which to continue to examine the Navy's future problems, and that it would be useful to reexamine the position of the Navy and the country every 5 to 10 years, to see what trends had been reinforced, what trends had changed, and how the differences would affect the Navy from then on.

At that time, the Soviet Union under Mikhail Gorbachev had already started to change its outlook and its strategy, and was presenting a more peaceful face to the world than had been the case in all earlier Soviet history. However, it still appeared that the Soviet Union would continue to be a major competitor to the United States and its allies for political influence on the world scene, and that it still would present a potentially serious military threat. The *Navy-21* report stated that

> The Soviet Union is expected to achieve many of the same technical capabilities as the United States over the time period, and to apply some of them in innovative and surprising ways. Soviet expansion of a base structure into Third World areas can be expected to continue. China could emerge as a major, modern industrial and military power over the next 50 years, and Japan may pay more attention to military matters than is currently the case. The U.S. and the world economies will become increasingly intertwined, continuing into the indefinite future today's trend to internationalizing the U.S. economy. The world economic environment and competition among the United States and its allies for markets will encourage the spread of advanced civilian and military technologies to Third World countries as well as to advanced industrial nations that are neutral or associated with either the Western or the Soviet alliances.
>
> U.S. maritime forces will therefore increasingly have to face potential conflict in many directions and areas, including third countries having advanced military equipment. The growing diversity and intensity of local political interests are likely to make our overseas base structure less secure, thereby enhancing the importance of a forward position based on flexible, mobile maritime power having less dependence on a fixed base structure. (p. 6)

Chart P.1 Purpose, Sponsorship, and Approach of Navy-21 Update

- Purpose: Revisit 1988 *Navy-21* forecast of Navy trends and technological opportunities in light of world events in the 5-year period from 1988 to 1993
- Sponsorship: Supported by Navy and implemented by the Naval Studies Board of the National Research Council; liaison with Navy established at high level via the Chief of Naval Operations
- Approach:
  - Review and revise the findings presented in *Navy-21, Volume I: Overview*
  - Produce a briefing book with charts outlining significant points

As the world situation has developed since, this forecast of the Navy's future operating environment proved to be accurate in all but one most important particular: it did not anticipate the total collapse of the Soviet system and the breakup of the Soviet empire and of the USSR itself. But that collapse, in 1990, placed all the other trends into a different perspective. The former Soviet republics are struggling as independent countries to create new forms of government and economies, which they may or may not succeed in doing. U.S. security and military power were challenged early by Iraq's invasion of Kuwait. The subsequent Desert Shield/Desert Storm campaign and civil wars in the former Yugoslavia, in some of the former Soviet republics, and in Somalia, to name but a few, have given graphic indications of the kind of post-Cold War, unstable world the United States and its allies face. The role and orientation of the Navy are being recast in terms suitable for a world in which all the other forces noted in the above quotation are working, in which the anchor and unifying influence of the "Soviet threat" do not exist, and in which a U.S. economy under severe competitive pressure from overseas must restructure itself to remain strong while devoting far fewer resources to defense.

The Naval Studies Board (NSB) of the National Research Council/ National Academy of Sciences concluded in the fall of 1992 that the changes in the world situation since 1988 warranted a current review of the 1988 *Navy-21* report, in the mode foreseen when it was initially completed (Chart P.1). Accordingly, the NSB arranged with the CNO to undertake such a review. Rear Admiral David C. Oliver, who had been the senior Navy

liaison officer for the original *Navy-21* study, was designated as the Navy's liaison officer to the study group.

To accomplish the study the Board again constituted itself as a committee of the whole for the purpose. A subpanel of the Board, augmented by some former members of the Board who had participated in the original study, prepared the draft of this report for the Board's review. Initial examination showed that the original *Navy-21* report retains much validity, and it has been augmented by recently completed NSB studies in the areas of future aircraft carrier technology; force projection; command, control, and communications; integrated fleet air defense; and mine warfare.[1] In these circumstances, it did not appear that a large group of study panels was necessary, as had been the case for the original study—much of the technical "homework" had already been done. Attention was needed to the impact of world events on the emphasis in application and use of technologies and techniques. The form of the report, a briefing, was chosen as a means to emphasize the key points of change and stability emerging from the review, and to expedite the study process so that the output could be quickly useful to (what became apparent after the update effort began) an incoming, new federal administration. Finally, it should be pointed out that future trends, particularly those of a geopolitical nature, are based on the informed opinion of the authoring committee and are not the product of detailed analyses.

[1] See *Carrier-21: Future Aircraft Carrier Technology, Volume I: Overview* (National Academy Press, Washington, D.C.), 1991; draft reports of *Space Support to Naval Tactical Operations* and *Naval Communications Architecture*, 1993, in preparation; *Integration of Hard-Kill and Soft-Kill Systems for More Effective Fleet Air Defense* (National Academy Press, Washington, D.C.), 1992; and draft report of *Mine Countermeasures Technology*, 1993, in preparation.

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Synopsis: Macro Themes

A few major themes emerged from this update of the 1988 *Navy-21* report, as indicated in Chart S.1. A sketch of the key points in each of the themes serves to summarize the results.

Synopsis: Macro Themes

Chart S.1 Synopsis: Macro Themes

- Orienting to a New Environment
- The Information War Is Crucial: Intelligence, Combat Information Network, Battle Management
- Air and Surface Forces: A New Balance—Precision Strike, Focused Defense
- Amphibious Forces: Enhanced Force Projection Ashore; Countermine Critical
- Undersea Forces: Other Than Strategic Forces, Shore Oriented
- New Approaches to Managing Technology and People
- Issues for Urgent Navy Attention

ORIENTING TO A NEW ENVIRONMENT

The environment in which the Navy must plan its forces and operate them has changed from the Cold War to what might be called an alert peace. With the massive military threat of the former Soviet Union in remission, the Navy (together with the other services) must face a strategic environment characterized by instability and shifting coalitions that depend on external events and regional interests. Diverse threats to U.S. interests can arise suddenly, in many parts of the globe, out of conflicts involving ethnic rivalries or religious forces, competition for resources and markets, and mutual adjustments among states whose quarrels were held in check by the previous competition between the superpowers. U.S. strategy is evolving to new frames of reference with our existing allies, and the reasons for military action on the world scene are embedded in regional interests. This creates pressure toward military action in coalitions (often arranged under United Nations auspices) that may shift with local conflicts, and reduces the availability of a secure overseas base structure that the United States can use

at will to further its own interests. Increasingly, the Navy will come to represent the U.S. forward posture for a military response to emergencies.

Potential U.S. military opponents may have advanced weapons and targeting capabilities, including some that the Navy has not had to give serious attention to in the past, such as modern mines, ballistic missiles with maneuvering, terminally guided warheads, and proliferating, quiet, advanced conventional submarines with advanced torpedoes. The Navy will be subject to the "tyranny of the single hit," in which a successful attack that seriously damages a major ship, or loss of aircraft to hostile action, can have political repercussions far beyond the immediate impact of the damage.

The planning environment in which the Navy creates and supports its forces has changed drastically, as well. Foremost among the new planning conditions are shrinking military forces and budgets, with stable levels not yet established. To achieve the greatest possible economy of force and the most effective utilization of resources in this environment, "jointness"—the military services working together under unified military and civilian command structures in all mission areas—has assumed high importance in U.S. military policy. In accentuation of trends that were under way during the latter years of the Cold War and that were illustrated powerfully in the Persian Gulf War, operations of all the services including their essential combat information inputs and support are orchestrated by a regional military commander. Intelligence activities in the Department of Defense are increasingly being consolidated in joint as well as national agencies. There is an increasing tendency to emphasize multi-service use of major systems, and to think about R&D and the technology base in terms of total-DOD rather than single-service needs. Finally, as a result of worldwide market forces as well as a shifting resource base, the Defense Department is becoming a major recipient of technology from the civilian economy rather than being a primary donor, as was the case in an earlier era.

In the new environment without the massive and highly integrated former Soviet threat, and with due attention to modernization to meet new threats as they emerge, the Navy is in a position to remain essentially unchallengeable at sea for the foreseeable future. The Navy and the Marines will often be the first on the scene in a crisis, and will have to prepare the way for other service forces to enter. A new mission emphasis for the Navy is emerging:

- The Navy will be oriented toward power projection in littoral warfare, including strike and amphibious warfare;
- The sea control mission will include protection of both the sea lanes and the terminals, and will emphasize establishment of regional air superiority; protection of ports, amphibious landing zones, and Navy ships

from attack by the tactical ballistic missiles that are proliferating around the world; and coastally oriented antisubmarine, mine and countermine warfare;

- Combat operations, intelligence and combat information input, mission planning, combat support, and logistics will usually be shared with other services and allies; and
- The Navy will continue to furnish the strategic undersea forces that increasingly constitute the deterrent against major attack on the U.S. homeland.

The form to which the Navy is evolving to carry out these missions includes the following key elements:

- Firepower distributed among many fleet elements, in the form of air-launched precision-guided weapons and surface- and submarine-launched tactical ballistic and cruise missiles;
- Distributed and layered defenses as before, with enhanced shipboard defenses focused on regional air, ballistic missile, and submarine threats; and
- All elements embedded in a growing, joint intelligence, combat information, and battle management sensor and communication network under regional commanders-in-chief (CINCs), involving Navy, other service, and National[1] sensors and communication systems, and heavy reliance on systems in space.

THE INFORMATION WAR IS CRUCIAL

Maneuvers and combat start with information. The war for information is crucial to informed, efficient, and effective operation of Navy and Marine forces. The information war encompasses intelligence; information about neutral, friendly, and opposing forces, their dispositions in general and in detail, and their activities; and battle management to orchestrate the combat operations of all branches of the Navy, Marines, and other services that may be involved. It also includes all the activities involved in denying such information to opponents and interfering with *their* battle management. The information war touches all activities from early warning of impending threats (from years to minutes in advance), through surveillance, finding of targets for aircraft and for ship- and submarine-launched missiles, orchestration of the operations of those forces

[1]The term "National" refers to those systems, resources, and assets controlled by the U.S. government, but not limited to the Department of Defense (DOD).

and systems while engaged in battle, and assessment of the results of their activities.

Advances in semiconductor, display, and software technology will revolutionize sensing and the Navy's ability to gather and to extract more, and more precise, information from weak and noisy signals. Such capabilities as high-resolution wide-area surveillance and identification of targets by radar and automatic target recognition with electrooptical systems will become fully practical, routine, and inexpensive. The ability of the Navy and the other services to exploit these advances will depend only on the rapidity with which they can be adapted from the basic technologies that are being developed rapidly in the civilian economy. Position fixing using the Global Positioning System (GPS) will revolutionize the Navy's location, navigation, and guidance capability against all kinds of targets. Despite available countermeasures against the most extreme exploitation of these capabilities by others, pressures for accurate position fixing in civilian applications will make available sufficient precision for potential opponents to endanger the fleet with new families of guided weapons. The need to protect against such a complex threat by information denial and countermeasures, while providing the Navy with the advantages that the GPS revolution offers, will add a new dimension to the information war in the coming years.

The Navy cannot fight or even operate usefully without over-the-horizon vision out to the limits of influence of battle groups and opposing forces. Essential information—which can take any form from early warning assessments to coded messages to imagery—comes from many sources, inside and outside of the Navy and its elements. Among them, space systems for navigation, surveillance, communication, and environmental information are an essential part of the information war's machinery. Although it does not own space systems, the Navy cannot function without them. In most cases, other service systems also furnish essential intelligence and target information, and other service-force components need inputs from Navy information sources. In addition to sensors to gather information, and terminals ashore and on ships and aircraft to receive and process it, there must be a sturdy communication network to carry the information from all relevant sources to all who need it, in appropriate time, with minimal errors, and with minimal opportunity for enemy interference or exploitation. For the Navy, this calls for communications connectivity among all of its own forces in an operation as well as connection of its forces with National, regional, and other service information systems and services. Battle management in a joint environment also means joint mission planning and interoperable command, control, and combat communication systems for the Navy, the other services, and the regional CINCs.

Although such connections are being made, the effort is far from complete. Thus far, the Navy has been building its own systems for information input and battle management, and has achieved an unprecedented degree of integration and interoperability among its systems. Much more remains to be done. Countermeasures and electronic warfare systems must be integrated with the combat information network as well as with appropriate weapon systems. Connections and interoperability with information, mission planning, and battle management systems of other services with which the Navy will have to operate have yet to be completed. Access to tactically useful information obtained from the National systems must be strengthened. To ensure effective implementation, a parallel program of testing and training, including exercises and simulation, should be undertaken. Someone must take the lead *in the joint environment* to complete the combat information system in all its dimensions, both to ensure that the systems Navy and Marine forces need are furnished and appropriately integrated, and to ensure the essential, "seamless" connectivity with the other service and National sources of information for mission planning and execution. The Navy is doing this in some appropriate areas and should consider where it must do so in others

Aircraft-carrying sensors for airborne early warning, sea-surface and antisubmarine targeting, and airborne electronic warfare systems have been an essential element of the fleet's battle groups. Many of these aging systems are ready for renewal. At the same time, capabilities for overland airborne early warning, for locating stationary and moving targets on land, and for electronic warfare have appeared through the years and are essential to air-land warfare. The latter systems operate in land-based aircraft, usually operated by other services. All such systems are expensive to develop, to buy, and to operate. The Navy now faces the question of how to distribute its information assets and sources among systems organic to the fleet and those from other sources, in light of its evolving shoreward mission orientation in the joint environment. The Navy must now plan the future evolution of the fleet's sensor systems and platforms for Navy and Marine purposes, with essential attention to joint use of National systems as well as those of other services.

AIR AND SURFACE FORCES—A NEW BALANCE: PRECISION STRIKE, FOCUSED DEFENSE

The balance needed between offense and defense, and the fleet's needs in each area, have changed.

In the offense, weapons, sorties, and time in which to prevail are too scarce to waste by delivering weapons that do not kill targets. This means

that the Navy's strike forces must increasingly be built around precision weaponry. The weapons will include long-range guided missiles launched from on and under the sea, air-delivered standoff weapons, and guided weapons for close-in fire support. The weapons will have to be designed as parts of total systems, in which finding of targets, weapon delivery to the target areas, guidance to targets, and assessment of damage are integrated together and matched to one another. Although precision weapons are individually far more expensive than free-fall bombs and artillery shells, when the overall delivery system costs, the costs of losses, and the cost of repeat attacks when weapons do not hit and destroy their targets are accounted for, the costs of attacks with unguided weapons will ordinarily be higher, per target killed, than the costs of destroying the same targets with precision attack systems. Shifting the Navy's strike forces heavily in this direction will reduce fleet capability for sustained attacks that deliver massed tonnage of bombs, as occurred in Southeast Asia. In the joint combat environment such attacks can be made by the intercontinental bomber force, as was the case in Desert Storm.

Modern technology has led weapon capability to the point that precision attacks from the sea with ballistic missiles, at long as well as short ranges, against mobile as well as stationary targets, have become feasible and in many cases desirable. Although such missiles by the nature of their trajectories and speeds have less range than cruise missiles for a given volume and weight, they can nevertheless be designed to reach distances of many tens and some hundreds of miles, with useful warheads, within the same missile "envelope" as Tomahawk-size cruise missiles. If they had appropriate submunition warheads they could strike moving ground forces with significant effect. They would have the great advantage of rapid response (in a few minutes' flying time) to strike targets that can move. Such weapons will constitute a new fleet capability, to be integrated into the fleet.

With the fleet concentrating on precision strike, its strike aviation needs will change. Aircraft carrying a few precision weapons instead of many ballistic weapons will have longer range, so that the mission envelope of existing aircraft and those currently being acquired can be extended. Advancing anti-air system capability among potential opponents will place strike aircraft at increasing risk. The near-term risk can be mitigated by use of standoff precision weaponry as well as defense suppression and electronic warfare. In the long run, incorporation of stealth technology, rather than range and payload extension, will become a primary driver of new strike aircraft designs. Weapon integration while preserving stealth will be facilitated by the need to carry fewer weapons when they are precision-guided. New sensor and communications technology will change sensor aircraft design characteristics. Priorities will have to be adjusted

between combat aircraft and the organic sensor aircraft discussed above, in a tight resource environment that allows few simultaneous major platform acquisitions. Integrated planning of the overall strike system, including targeting, weapons, weapon delivery, and damage assessment, all integrated and matched to each other, and including the naval aircraft mix and acquisition sequence, is needed for the new environment and mission orientation.

In defense, the Navy has been relieved of the pressure to extend its air and missile defenses to meet an ever-growing threat at ever-increasing distances. The fleet's defenses will keep it safe in sea warfare until a new, sophisticated, highly integrated opposing attack capability dedicated to the fleet's destruction, as was the former Soviet threat, appears. However, the fleet's defenses have to be "tuned" to meet the new mission requirements in the newly emphasized operating environment. Major Navy ships including carriers will remain vulnerable to attacks by many advanced weapons, and they will be operating in coastal waters where such attacks will be more likely. If the attacks are successful they could have political repercussions far beyond their immediate effects. Enhanced fleet defense requires better integration of soft-kill and hard-kill systems, extension of ship self-defense systems to ensure success against proliferating stealthy antiship cruise missiles, enhanced torpedo defense, improved countermine warfare capability, and improved ship damage control to mitigate the effects of hits. Also, since the fleet may be called upon to defend local terminal areas such as ports and amphibious landing zones, as well as its own ships, against ballistic missile attacks that could in the near future have maneuvering, accurate warheads, the AEGIS system must be upgraded to have an anti-tactical-ballistic-missile capability—against ballistically incoming warheads initially, and subsequently against maneuvering warheads.

AMPHIBIOUS FORCES: ENHANCED FORCE PROJECTION ASHORE; COUNTERMINE CRITICAL

Amphibious operations remain the key means for projecting land forces ashore with tactical air support, in the absence of prearranged bases. Many landings will be administrative, to put the troops ashore, provide them air cover, and initiate the base-building process with no significant opposition, as occurred in Somalia. Although in the modern context opposed landings of the magnitude of the Normandy invasion are not contemplated, there will still be occasions when landings of significant forces will have to be made against serious opposition. Modern defenses can render such landings exceedingly difficult and will require enhanced amphibious force capabilities involving Special Operations Forces; a light,

high-technology, stealthy "spearhead" echelon that can prepare a landing zone for more conventional forces to follow, or perform a combat mission and be extracted, depending on the situation; and a more conventional follow-on echelon that constitutes the main force or that can, in situations of low threat, be the primary force. All these forces must be embedded in a common combat information network. The technology for the forces will be derivative from that of the Navy and other services.

A critical element of opposition to amphibious operations will be mine warfare, especially in shallow waters and in the beach zone. Mine warfare can frustrate amphibious operations and can hold the fleet and Marine landing craft at high risk, as Desert Storm illustrated. The first step facing the Navy in preparing for effective countermine warfare in amphibious (or any other) operations is to recognize the importance of the problem and to adjust its personnel assignment and command systems accordingly. After that, attention is needed to mine warfare intelligence, surveillance, and reconnaissance from air, surface, and subsurface forces. Then, technology and forces for mine detection and neutralization must be enhanced, with special (but not exclusive) attention to shallow water and the beach zones.

UNDERSEA FORCES: SHORE ORIENTED

The strategic submarine force will remain invulnerable in the new environment for the foreseeable future. The tactical submarine force will have to devote part of its effort to guarding against possible strategic attacks, as was the case during the Cold War. Mainly, however, the tactical undersea force will be able to devote its attention to protecting the fleet and shipping, and to strike warfare.

Antisubmarine warfare remains important in the new environment. Opposing, modern, conventionally powered submarines can be highly dangerous in coastal waters. They are quiet when submerged, and underwater sensing conditions are difficult. Such submarines could inflict unacceptable losses on U.S. and allied shipping or surface combatants. If the Russian torpedo capability that was designed to attack our carriers were to be sold to Third World countries, a carrier might be sunk if its defenses were not adequately alerted. Such submarines could also engage in mine laying, and they could launch weapons of mass destruction, leaving the source ambiguous to reduce the chance of retaliation. Thus, although the submarine threat is not nearly as capable and focused as it was during the Cold War, continued attention is required to antisubmarine warfare in the coastal environment.

The START treaties will take nuclear-powered ballistic missile submarines (SSBNs) out of the strategic force. With suitable adaptation the

SSBN missile tubes can be loaded with and can launch up to 336 Tomahawk-size missiles per boat. Attention to recognizable, observable differences between the converted submarines and SSBNs, and assurance that tactical nuclear weapons were not at sea, would be needed for arms control purposes. Then, each submarine would become a formidable nuclear-powered guided-missile submarine (SSGN) able to engage in strike warfare in a major way. The advantages of such conversion and the use of the SSGN include lower cost than the acquisition or conversion of a major surface combatant with equivalent firepower; smaller crew than surface combatants; stealth that precludes vulnerability to antiship missiles and avoids the need for multiship battle forces to protect the strike "force"; and the ability to spend more time on station without forward base support than surface forces.

Use of the SSGN requires assured connectivity with surface forces and the CINC, for target information and for tactical coordination. Such connectivity was viewed as constituting a vulnerability for a submarine in the face of the highly sophisticated and integrated opposition of the former Soviet Union The risks in maintaining the connectivity would be much smaller today.

NEW APPROACHES TO MANAGING TECHNOLOGY AND PEOPLE

The sources of technology for military use have become more complex, and the Navy will have to change the way it plans and acquires systems to adapt successfully to the new conditions. In areas such as the computing and communication technologies, many sensor applications, materials, and manufacturing, the Navy will depend on adapting civilian technology, often derived from international markets, to its needs. Other technologies, such as explosives and some sensors, will remain unique to military applications. A growing area of technology application, namely, widely distributed networks of weapon and platform simulators, will affect the processes of determining military requirements, training, and battle planning in many ways. In many technology areas, especially those derived from the civilian world, the time in which technology turns over is now less than the time for acquisition of new military systems.

In this new environment, which affects all of the services, the DOD will have to devise new ways of managing its acquisition and use of new technology. The Navy need not wait; it can take steps on its own to adapt to the new conditions. Such steps include planning for more frequent subsystem turnover as major platforms are retained for longer periods in a persisting, austere budget environment; designing new platforms to accept subsystem changes more readily during their lifetimes; using the advanced

simulation techniques to explore the military value of new concepts before committing to them; and using prototyping and civilian procurement practices and standards more, modifying the military acquisition processes to accept civilian standards that are appropriate for military-unique technologies.

Personnel represent a major part of Navy costs. The population in uniform will be more varied, involving more minority and women members, and advanced technology will demand high skills while conditions change for retaining skilled personnel. Competition with the civilian economy will keep the costs of acquiring and retaining personnel high, while skill requirements will elevate training costs. Modernization of personnel acquisition, assignment, and training techniques can lead to enhanced productivity, which in turn can help reduce crew size. Personnel-intensive and dangerous tasks can be aided by "intelligent machines" added to the force as they can be made available. These will be highly varied, including such things as computer-aided logistic, diagnostic, and repair systems; unmanned aerial and undersea vehicles for reconnaissance and associated tasks; automated ammunition handling; and "instrumented ships" to signal sources of damage, aid in its control, and incidentally help achieve the economies of condition-based maintenance. Extensive use of simulation will help keep costs lower in training and in maintaining readiness.

At the same time, the Navy will need sources of trained personnel in periods of rapid force expansion. Like the other services, it will have to rely on reserves for such things as filling in cadre ship crews and adding to understrength units in times of emergency. The value of reserves is a matter of some controversy, and reserves in different branches have displayed various degrees of capability. For them to be useful in periods of rapid force expansion their skills must be built to modern standards and maintained. This requires that they train frequently, with modern equipment of the kind they will operate when on active duty. Simulation of systems and of networked forces can help, but will require investment in simulator networks for training. Some reserve policies of long standing, such as call-up of reserves in units instead of as individuals to fill out active units, and chains of command that run through the states, can inhibit flexibility in training the reserves and using them in emergencies. While some reserve units, especially in the air reserves, have been considered highly effective, in general all reserve policies and practices need review and revision if the reserves are to serve as a source of trained, ready personnel for force expansion in an emergency. If the changes are not made, expenditures on the reserves will not achieve their desired goal of rapid force expansion in emergencies.

All the steps outlined above to enhance personnel capabilities and availability will entail increasing costs in many personnel-related areas, even

as the costs are reduced in others through changed personnel practices and capital investments to extend personnel capabilities. On balance, the personnel-related costs for implementing the policies and practices sketched here will be significantly less than the costs of maintaining active combat units of equivalent capability.

ISSUES FOR URGENT NAVY ATTENTION

In summary, the following issues that have been identified in this review, presented in rough priority order, require urgent Navy attention:

- Initiatives for full Navy participation in joint information acquisition and battle management planning and operation;
- The mix of fleet sensor platforms and systems and those furnished from the outside, including the implications of the mix for carrier aircraft system design and acquisition;
- Design of integrated weapon, targeting, and delivery systems for precision strike;
- The evolution of the Navy combat aircraft force, considering end-to-end strike system design, relative priorities of sensor and combat aircraft replacement needs, and the need to integrate stealth and precision weapons;
- Planning early defense enhancements for the new environment, including countermine warfare, enhanced ship defenses against stealthy cruise missiles, AEGIS and standard missile (SM) upgrades to meet the ballistic missile threat, coastal-area antisubmarine warfare (ASW), and improved ship damage control;
- New policies and procedures for management of technology modernization;
- Revised personnel management, reserve training and equipment, and reserve mobilization policies, to maximize personnel capability and to enable rapid and effective force expansion in an emergency; and
- Planning for conversion of retired SSBNs to SSGNs and their integration into the fleet.

1
Orienting to a New Environment

NEW STRATEGIC ENVIRONMENT

Charts 1.1 through 1.5 outline changes in the Navy's operating and planning environment between the release of the *Navy-21* report in 1988 and this review. They also indicate the new directions and mission emphases that are evolving and must continue to evolve as the Navy adapts to the new strategic and national security planning conditions. In general the charts speak for themselves, but a few points are worth emphasizing and elaborating.

Orienting to a New Environment

Chart 1.1 New Strategic Environment

- Massive "Soviet threat" in remission
- Other threats to U.S. interests can arise suddenly, anywhere
  - — Internal instabilities worldwide
  - — Ethnic, religious, economic, border conflicts rampant
  - — Realignment among existing and growing world power centers
- Many potential opponents play by different rules
  - — Terrorism, willingness to sustain casualties, political use of prisoners-of-war (POWs) . . .
- Many sources promote proliferation of advanced weaponry including weapons of mass destruction

Even in the late 1980s the U.S. Navy faced, in the Soviet Union, a maritime warfare capability founded on undersea and aviation forces, with growing sea-surface forces, all tightly integrated through a command and control system having multiple pathways and strong central direction. The purpose of this opposition was to defeat the U.S. Navy. Although the Soviet "hard-line" counter-U.S. policy was apparently softening after the 1985 accession of Mikhail Gorbachev to the leadership of the USSR, the Soviet military threat was still expected to become more capable and sophisticated as time went by. While it was noted in *Navy-21* that Third World military

capabilities were improving and that the operating conditions facing U.S. maritime warfare forces in the Third World would become more severe, the capability to oppose Third World military forces was viewed as deriving largely from the counter-Soviet capability that absorbed most of the resources available to the U.S. Navy.

The missions of the Navy in 1988 were dominated by awareness of Soviet maritime warfare power. The amount of U.S. fleet effort and resources devoted to defense of the fleet was viewed as disproportionate, and there was pressure to simplify and better focus the defense so that more resources could be devoted to offensive warfare. Soviet as well as U.S. submarine quieting were making antisubmarine warfare (ASW) more difficult for both sides, but it was anticipated that by dint of very high priority to the area and sustained effort the United States would be able to maintain its undersea warfare lead. Dispersal of the fleet for offensive warfare and improved ship self-defense were visualized as means to maintain the ability to achieve surprise and to protect the fleet against opposition, both Soviet and Third World, that would include better surveillance; command, control, and communications; more mobile forces; and weapons incorporating stealth technology.

In 1993, ethnic, religious, and economic conflicts, and conflicts of mutual adjustment between rival nations, have come to the fore. Barring a resurgence of hostile Russian military power resulting from instability in the political and economic conversion processes and the ethnic adjustments that have been put in train, the primary military concerns of the United States and the other industrialized countries of the world derive from the turmoil in the developing world. New regional political blocs and power centers will arise, some involving coalitions of developing countries or alliances between those countries and the industrialized countries as the former strive to improve their economic condition and the latter strive to cement their ties to resources critical for their survival. The United Nations will often be involved in forming the coalitions, to maintain the legitimacy of military action to suppress threats to the peace and to coalition interests.

A new, massive, and sustained threat to U.S. interests may arise out of this ferment. In the meantime, the ferment ensures that crises involving the United States and U.S. interests can arise suddenly and almost anywhere in the world. Having to bring our military power to bear in different regions will lead the United States into varying coalitions over different issues. All this reinforces our dependence on the Navy and its mobility to be able to reach a crisis scene and sustain an early presence there when bases for U.S. tactical air and ground forces are not immediately available for political or any other reasons, and to augment the U.S. military presence even when land bases are available.

Regional conflict is likely to challenge U.S. conceptions of the nature of military engagement. The developing countries do not "play" by the rules, such as the Geneva Conventions, that the United States and its allies have accepted to govern the practices of warfare. Starvation and other forms of genocide are, to them, acceptable means of resolving conflicts among ancient enemies and of subjugating or eliminating opposing populations. They have used state-sponsored terrorism against superior military powers. As we learned in Vietnam and even in the Persian Gulf, their rulers are willing to sustain heavy casualties and to use prisoners and hostages to achieve political goals. Deterrence by the threat of force against such opponents is more difficult than among the industrialized nations; as Saddam Hussein made clear, he viewed the threat of high casualties as a deterrent against the United States rather than against himself.

The nations in what used to be known as the Third World are seeking advanced weaponry and weapons of mass destruction. Advanced weaponry comes to them out of the competitive pressures in the industrialized world, including the United States and its allies, to sustain high-technology economies threatened with decline by the reduction of arms acquisition. Russia is viewing arms sales as a source of essential foreign exchange in attempting to transform its economy. China and North Korea have appeared as important sources of weapons for many countries hostile to the United States. Finally, the developing nations themselves, by virtue of their industrial development, and using advanced, dual-use technology sold to them legitimately in open markets, are reaching the position where they can build their own weapons. Chemical and bacteriological warfare capabilities are extant now. It is only a matter of time until more of those nations acquire nuclear weapons. Delivery systems in the form of ballistic missiles with ranges of hundreds to thousands of miles and guidance at least accurate enough to hit a city, and probably better, are also appearing worldwide. Thus, future conflicts involving developing nations, the United States and the industrialized countries could assume proportions and characteristics highly detrimental to U.S. and other industrialized nations' long-term security. The Navy will not only have to meet today's threats, but it will also have to be postured so that it can expand to tomorrow's threats when they appear.

NEW DEFENSE PLANNING ENVIRONMENT

Our alliances, built on the foundation of a common and severe security threat, are now less tightly knit. The United States can no longer count on the ready availability of an overseas base structure from which to defend its own interests, and it can no longer be assumed that our interests

will coincide with those of our allies. Desert Shield/Desert Storm and the ongoing aftermath have illustrated the constraints in coalition warfare involving complex regional issues that change over time. The Navy, as a U.S. force component that can deploy to any region in the world without impinging on any nation's sovereignty, represents our "forward posture" to a greater degree than at any time since the end of World War II. A new U.S. strategy to meet the new strategic conditions has been evolving slowly, as events unfold to illuminate the new world conditions.

However, the defense planning environment has been changing rapidly (Chart 1.2). At the time of the original *Navy-21* study, although U.S. defense budgets were already declining it was nevertheless anticipated that the resources would be available for Navy modernization, including some expensive new systems essential for survival against an improving Soviet threat. Today, our military budget is declining at the rate of about 5 percent per year, to some currently uncertain level. The Navy's budget, alone, has declined over 40 percent since Fiscal Year 1989. The problem for the U.S. armed forces now is how to sustain adequate military power to protect U.S. interests while reaching a much smaller size and acquiring far fewer new military systems than they planned to acquire a few years ago.

Orienting to a New Environment

Chart 1.2 New Defense Planning Environment

- Revised U.S. security strategy evolving slowly
  - Traditional military alliances weakening
  - Shifting and constraining regional coalitions
  - Secure overseas base structure coalition-dependent
- Revised U.S. defense posture evolving rapidly
  - Military forces downsizing
  - Jointness is key: in C^3I, operations, systems acquisition, logistic support
  - Intelligence resources declining, being centralized
  - Defense industry shrinking: key technologies centered in civilian economy and overseas

"Jointness" in all areas of military endeavor is now essential for reasons of economy of force in operations and economy in creating the forces, even beyond the military imperatives that were leading to increased emphasis on the role of the regional commanders-in-chief (CINCs) even before the collapse of the Soviet Union. Some resources, especially those

involving space, have always been furnished from outside the services, but more attention is currently being given to ensuring that those resources serve all users adequately. In the new budget conditions, there is increasing demand that other support, such as refueling and logistics, be joint. Military intelligence is being consolidated under joint agencies including the Defense Intelligence Agency (DIA) and the Joint Staff, with service intelligence activities declining in size and, ultimately, in importance. Increasingly, it is being required that the services share new system research, development, and acquisition to a much greater extent than previously.

Outside the individual services, in reinforcement of a trend that became apparent over a decade ago, the United States is no longer self-sufficient in the resources, capabilities, or goods that underlie military power. This dependence can only continue as the defense industry shrinks and civilian industry furnishes more of the underlying technologies of military systems, continuing another trend that began in the 1970s. Within the individual services, personnel resources are more difficult to manage. The Navy, along with the other services, can expect to deal with a more varied population in uniform, including women and many minority groups, posing more difficult problems in building and sustaining necessary skill levels. At the same time, budgets for training and readiness, spares, and maintenance will decline with force size.

The Navy is thus faced with a more complex task than it had in the days of the former Soviet threat, and it will have to carry out that task in a joint environment, at smaller size, with fewer resources and with less control over the resources that are available.

POTENTIAL OPPOSITION TO NAVAL FORCES

None of the potential opponents of the U.S. Navy is likely to be as well organized or to have the large forces and long reach with which the former Soviet Union confronted us, for some time to come—perhaps several decades, depending on potential developments in Russia or the appearance of some other country or coalition that may try to emulate the Germany of the 1930s in military growth. Even if some of the key elements of former Soviet power, such as nuclear submarines or long-range bombers with missiles, were to be sold abroad by the Russians, the purchasers would not immediately reach the degree of mass and organization that characterized Soviet forces. In that sense potential military opposition to the Navy has been greatly eased. The Navy, if it maintains the current combat capability of its battle forces (not necessarily the numbers of battle forces), can be expected to remain essentially invincible at sea for some time to come. While individual ships and aircraft may be hurt and possibly destroyed,

barring the unexpected use of nuclear weapons the defeat of a battle force is highly unlikely.

However, the main opposition to naval forces will not be at sea in the new world situation. As the Navy turns its attention to the littoral or coastal areas of the world, much sophisticated (or even crude but massive) opposition can be expected in those areas. Chart 1.3 lists the primary weapons the opposition might bring to bear. Most exist now, and those that do not can appear within our response timelines; the technology is available. None are or will be easy to overcome. For some—including sophisticated mines; stealthy, countermeasures-resistant anti-ship cruise missiles; and ballistic missiles with maneuvering, terminally guided warheads that can attack ships—we have not yet found the preferred solutions.

Orienting to a New Environment

Chart 1.3 Potential Opposition to Naval Forces

- U.S. Navy invincible at sea for many years to come
- But sophisticated capability abounds:
  - State-sponsored terrorism, advanced technical support
  - Mine warfare, minefield air cover
  - Surveillance and targeting from space
  - Air defense networks, with EW, and attack aviation
  - Proliferation of anti-ship cruise missiles—stealthy, EW resistant
  - Quiet non-nuclear submarines, modern guided torpedoes
  - Tactical ballistic missile (TBM), vs. terminals, bases, cities; terminally guided missiles vs. ships
  - Chemical, bacteriological, and eventually, nuclear weapons
- Political tyranny of the single hit

While it may be difficult for the opposition foreseen to defeat an entire battle force, it will be possible for that opposition to shoot down aircraft and to seriously damage or even sink a ship. If this were to happen, especially with a large number of casualties, it would be acutely embarrassing to the United States. The event could create a political crisis, including inquiries as to cause, casting of blame, and rolling of heads. There were events in the Persian Gulf that presaged this, and would have been much

worse if the ships hit by mines and missiles had been sunk. The United States is thus subject to the "tyranny of the single hit" in regional warfare. In this sense, the task of the opposition is easier than ours—the Navy, if it goes into combat, must defeat the opposition, while the opposition can settle for injuring the Navy and seeking a political victory. The United States learned about this asymmetry in Vietnam, in an air attack on Lebanon, and in the Persian Gulf. It requires not only that the Navy win against the opposition, but also that it not be hurt very much in the process. The ballistic missile with a nuclear warhead, which could appear in the hands of a developing country, would permit blackmail, which would intensify the asymmetry—potential destruction of a major ship at sea, while retaliation would kill innocent civilians. The demands on intelligence, combat information, counter-weaponry, and tactics are great.

EMERGING FLEET MISSION EMPHASIS

The traditional mission set of deterrence, power projection, and sea control has not changed, but emphasis among the elements of the set has changed significantly (Chart 1.4). With little threat to the Navy at sea and with the primary threats to U.S. interests coming from forces on land, the attention of the maritime warfare forces has turned landward and the power projection mission has come to the fore. This circumstance emphasizes the need for integrated action by all forces, including Navy and Marine forces, in the joint environment, under command of the regional CINC. This extends to the forces of other nations when we engage in warfare as part of a coalition.

In some situations the Navy may have the only forces on the scene, or the available Navy forces that reach the scene may be able to deal with the situation by themselves. Especially where bases are uncertain and a strong military presence is required, the Navy would be ideally positioned to sustain such a presence for an indefinite period. Potential opponents will have been alerted so that strategic surprise is difficult to achieve, but tactical surprise rests with the battle group commander.

In major crises, other forces will come into play as coalitions are formed and bases are made available. Until then, the Navy must concentrate on achieving and maintaining regional air superiority and local sea control in the area of operations, on protecting the terminals in those areas, and on putting troops ashore if needed and supporting them afterwards. Scenarios can be visualized in which the Navy is assigned simultaneously to clear mines from a harbor or a restricted sea, to protect shipping from submarine threats in such seas and on the approaches to harbors, to provide air superiority and a port defense against a ballistic missile threat for some indefinite period

while commercial and military shipping intermix in a reception region, and to land Marines to prepare land bases and protect them. Limiting collateral damage attending combat will always be imperative; it is likely that major military operations will take place around major population centers. If major combat erupts on land, even without bases for other forces the Navy can be augmented as needed by the intercontinental bomber force if massive, sustained tonnage of weapon delivery is needed. All these conditions call for Navy concentration on precision strike capability in addition to its defensive arms and provision of close fire support for troops ashore.

Orienting to a New Environment

Chart 1.4 Emerging Fleet Mission Emphasis

- Power projection: Emphasis on precision strike, air superiority, amphibious warfare, fire support
  - — Little current open-ocean threat; Navy shore oriented
  - — First-force-"there" presence; establishing and protecting positions ashore until sustaining forces arrive
  - — Complemented by intercontinental bomber force for massive weapon delivery
- Protect the sea lanes and terminals
  - — Counter quiet, non-nuclear submarines
  - — Provide regional air superiority and local ATBM protection
  - — Counter hostile mine warfare
- Provide and operate strategic undersea forces
  (Little changed except numbers and targeting)

Threats to naval forces and shipping at sea will remain and will tend to increase over time for ships that may encounter mines or sail within reach of land-based aircraft, anti-ship cruise missiles, ballistic missiles that can attack ships, and the growing worldwide fleet of advanced conventional submarines. Therefore the Navy's traditional mission of maintaining freedom of the seas and protecting the sea lanes will continue. Traditional fleet defenses will have to be augmented by expanded countermine warfare capability, extension of open-ocean antisubmarine warfare into the coastal zones, and the ability to achieve warhead kills against tactical ballistic missiles targeting the fleet or adjacent resources that the fleet is protecting.

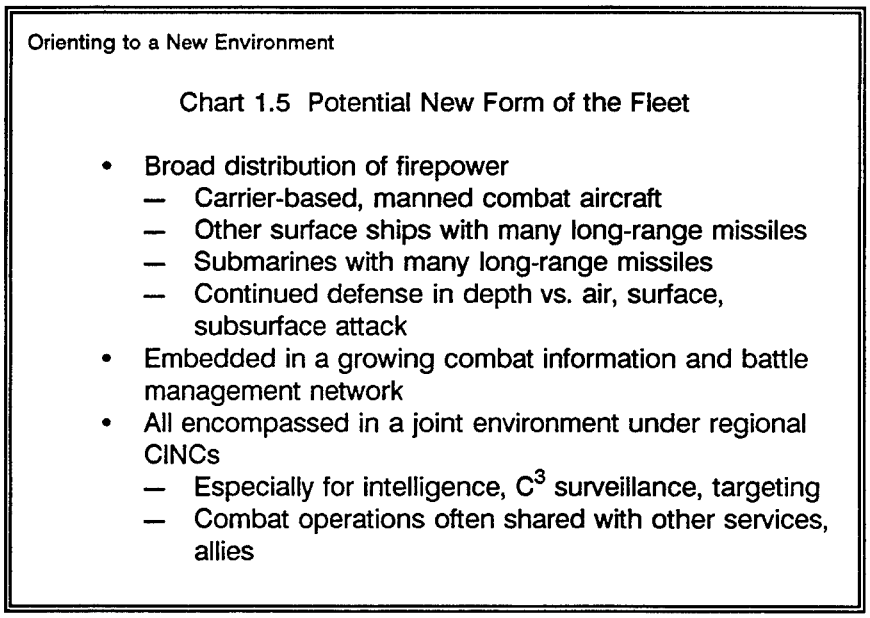
The strategic deterrence mission also continues and remains essential to discourage major attacks on the U.S. homeland by any country that has or that may develop an intercontinental nuclear capability. Except for numbers of nuclear-powered ballistic missile submarines (SSBNs) under START II and the revised strategic command structure, little will change. In the absence of the highly capable and integrated former Soviet attack submarine fleet, the Navy's SSBN force will remain invulnerable for the indefinite future.

POTENTIAL NEW FORM OF THE FLEET

Whereas the conventional striking power of the fleet has in the past resided mainly in its carrier attack aviation, the ability to carry and launch many long-range tactical missiles from vertical launch bays on other surface battle force combatants (BFCs) and from vertical launch bays or tubes on submarines means that fighting power can now be more evenly distributed in the fleet (Chart 1.5). This redistribution of fleet combat power will provide greater operational flexibility for a smaller fleet. The missile-carrying ships and submarines will be able to constitute capable combat forces on their own in many situations that may be appropriate for one or the other type of system; they may carry out precision strikes as they did by launching cruise missiles in Desert Storm and in the Navy strike against Iraqi intelligence headquarters in June 1993; or by suppressing key defenses they may pave the way for the carriers and their aviation to undertake sustained strike-and-fire support missions in more demanding scenarios.

The fleet's defense in depth continues. It will still include carrier-based interceptors, long-range surface-to-air missiles (SAMs), close-in ship defenses, and ASW capability distributed among land-based patrol aircraft, fleet-based aircraft, ships, and submarines. The defenses will have to be tailored to new threat configurations, as is described below.

The entire fleet will be embedded in the joint combat information network, including operations with other services and other nations' forces. Appropriate targeting subsystems will have to be part of the integration of the ships and submarines into the overall combat information network. Thus, a Navy emerges that has distributed firepower for offense and defense, and that operates with other services and other nations as part of military forces constituted flexibly as needed and as base structures allow, for regional operations.


Orienting to a New Environment
Chart 1.5 Potential New Form of the Fleet
• Broad distribution of firepower
— Carrier-based, manned combat aircraft
— Other surface ships with many long-range missiles
— Submarines with many long-range missiles
— Continued defense in depth vs. air, surface, subsurface attack
• Embedded in a growing combat information and battle management network
• All encompassed in a joint environment under regional CINCs
— Especially for intelligence, C3 surveillance, targeting
— Combat operations often shared with other services, allies

2
The Information War Is Crucial

INTELLIGENCE; INDICATIONS AND WARNING

Intelligence is one of the most important tools that will affect how the Navy meets both its current and future situations. The Navy needs extensive intelligence on developments that may lead to warfare involving the Navy in different parts of the world, and on the structure and capabilities of potential opponents, so that it can posture itself to deploy rapidly to a crisis location and be fully effective with the appropriate force when it arrives (Chart 2.1). Timely deployment to operations areas requires appropriate indications and warning (I&W) activities and supporting systems. These observations have always been true of the intelligence input to military forces and operations. They are even more urgent now that forces will be smaller and stretched across a larger geographic scene.

The Information War Is Crucial

Chart 2.1 Intelligence; Indications and Warning (I&W)

- Intelligence, I&W Essential for successful operation of naval forces
  - To scope out and anticipate future opposition
  - To know about specific technical and operational qualities of potential opposition
  - To anticipate and prepare to meet hostile action
  - Vis-à-vis many different geographic areas around the world
- New environment demands Navy participation in joint agencies and National intelligence activities
  - To ensure Navy and maritime warfare needs are met
  - Limited resources shrinking service agency capabilities
  - New, worldwide scope too big for single-service coverage

The strategic, tactical, and technical scope of potential conflicts and the wide distribution of potential conflict areas put the resources needed to

gather, process, and disseminate the necessary intelligence beyond the reach of any single service. For this reason, the Navy and the other services will have to pool their resources so that each gathers the intelligence that it is best able to gather, while all have ready and timely access both to data and to finished intelligence that any service(s) or national agency may have been instrumental in obtaining. Trends in this direction were demonstrated in Desert Shield/Desert Storm and the subsequent reorganizations of the intelligence community; they are still under way. The Defense Intelligence Agency's (DIA) role vis-à-vis threat reviews for service development programs has been enhanced; a Joint Intelligence Center to support the joint chief of staff (JCS) and the CINCs has been established by the DIA; the DIA will control DOD signal intelligence activities; and enhanced signal intelligence (SIGINT) responsibilities have been assigned to the National Security Agency (NSA). The reorganization of the Reconnaissance Support Activity (RSA) is also part of this consolidation.

In the developing intelligence organizational picture across the entire DOD and the national intelligence agencies, the Navy and the other services will need and want to be the beneficiaries of and participants in obtaining and processing national intelligence and the products of the joint intelligence agencies. Lack of such involvement will lead to a high risk of poor interservice coordination and planning, and a consequent waste of operational resources or, worse, increased casualties and the chance of failure of an entire operation. The Navy must ensure that it plays its full part in these joint activities.

THE COMBAT INFORMATION NETWORK

In the *Navy-21* study it was indicated that the acquisition of information at all command levels and for all military purposes about opposing, neutral, and friendly units and activities for use by U.S. (and by extension, allied) forces, and denial of such information to opposing forces, are critical requirements for effective operation of the fleet and the Marines. At that time the characterization of the "information war" anticipated highly integrated, redundant information acquisition and denial and command, control, communications, and intelligence (C^3I) procedures and systems on the Soviet side. Since in most scenarios the Soviet forces were expected to have the tactical initiative, success in the information war was seen to be crucial to success in any military operation against the threat foreseen.

Today the situations anticipated and the scenarios are different, but the need for success in the information war is even greater. The Navy will have to maneuver dispersed forces rapidly and effectively in locations to which the forces may have to deploy over long distances on short notice,

arriving with high readiness to undertake a potentially large and uncertain variety of activities. Only with full situational awareness and information about all the participants, and the ability to mask the fleet movements as long as possible until it is desired for deterrence purposes that they be known, will it be possible to bring the forces to bear with great effect in the shortest possible time (Chart 2.2). In the joint environment the task will require a high degree of coordination among Navy systems and those operated by national agencies and the other services. A workable combat identification system in this environment will be essential.

The Information War Is Crucial

Chart 2.2 The Combat Information Network

- Includes intelligence input, surveillance, combat ID, targeting, battle damage assessment, connectivity, countermeasures, and counter-countermeasures
  - Global basis, regional focus
  - Conditioned by revolutionary advances in sensing, position fixing
- Warfare from the sea requires integration of all available information and information denial
  - All-source intelligence
  - Other sensor systems regardless of ownership
  - All forms of information denial including countermeasures, embargoes, deception—all levels
- Navy can't function without space systems
  - Global Positioning System (GPS), surveillance, environmental sensing, connectivity

In addition, the Navy, together with the other services, faces revolutionary technological advances in sensing and position fixing that will change the nature of the information that can be gathered, how the information is used, and the risk of opposing countermeasures. Sensor advances, including especially various new approaches to phased-array radars and to focal plane infrared detector arrays, will be facilitated by advances in both the hardware and software of signal processing, computing, and imaging technology. These technologies are moving rapidly in civilian areas to enable tighter packing of solid-state components, faster processing, and richer displays in lighter weight systems. Applied to military sensing and guidance systems, the advances will enable extraction and use of more

information from weak or noisy signals in shorter times. Eventually they will make such capabilities as automatic target recognition with electro-optical systems and high-resolution wide-area surveillance and identification of targets by radar fully practical, inexpensive, and routine. The underlying semiconductor, display, and software technologies continue to advance at rates that show no signs of abating. The timing of the arrival of the capabilities they will offer for military systems depends only on the budgets allocated and the ability of the military R&D system to adapt the technologies from civilian applications in which they are being developed to military uses.

The Global Positioning System (GPS) also represents a revolutionary advance in military technology. It makes possible extreme precision in position location of sensors and therefore of targets, in location of one's own systems and their navigation to targets, and in weapon guidance. It also opens a new field of countermeasures to opponents of friendly forces. The GPS satellite signals will, in commercial application, be available to any user, facilitating guidance of opposing weapons against the fleet. Although countermeasures are available to inhibit full hostile exploitation of such a capability, the pressures for accurate navigation in the civilian world are likely to leave any opponents to U.S. naval forces with enough GPS-based precision navigation and guidance capability to make them dangerous to the fleet and its bases. Such guidance capabilities may be developed and sold in the open market by any technologically advanced country, just as earlier antiship and antiaircraft missile technology has been. The need to protect against such a complex threat by information denial and countermeasures, while providing the Navy with the advantages that the GPS revolution offers, will add a new dimension to the information war in the coming years.

The information system within which the Navy will have to operate will not be complete until all the relevant systems, regardless of who "owns" them, are assembled and interlinked. Thus the Navy will have to give R&D, procurement, and operational attention not only to its own systems but to those of the other services and agencies and to the interfaces among them. To this complexity will be added the frequent additional burdens of operating with coalition forces who will have still different systems, doctrines, and procedures.

The Navy (along with the other services and the joint commands) is already so dependent on space systems that it would be impossible to function without them. Surveillance from space is already a national capability whose results all the forces under a CINC share. The Global Positioning System (GPS), being emplaced, offers inexpensive but accurate weapon guidance along with the originally intended applications to navigation and position fixing. If forces of all services operate in a common

GPS grid, then joint force coordination for maneuver, targeting, and weapon delivery can be accomplished efficiently and effectively. Most communications, exclusive of backup modes, already use space systems. Direct downlinks to ships, on which satellite terminals can be installed, can tie them into a common system for cooperative engagement not only among ships of a battle force in their own defense but also for purposes of strike and attack effectiveness assessment involving all service components in offense and defense. Access to weather data obtained by satellite is also essential, and the Navy depends on satellite systems for ocean data as well.

Although space systems are mainly parts of national capability outside the Navy and are operated by other services and national agencies, it is essential that the Navy contribute fully to the specification of requirements for the systems, and that it participate in their support and management to the fullest extent necessary to make certain that the operational needs of the Navy and Marine Corps are met.

BATTLE MANAGEMENT

Navy operations reach to objectives hundreds of miles away from naval battle forces and Marines ashore. The Navy needs over-the-horizon vision to manage those operations, regardless of the source of the resources for it (Chart 2.3a). It also needs to tie all the forces involved and their information sources together in real time for combat (and other) operations. Long awareness of the importance of this area has led the Navy to emphasize it and to provide top-level attention and integration, through organizational arrangements in the Office of the Chief of Naval Operations (OPNAV) and investment in many system advances. Substantial progress has been made, within the fleet. The machinery and approaches to obtaining the needed capabilities are largely known.

While it will continue to be necessary to have airborne early warning, electronic warfare, and antisubmarine warfare systems that can operate from ships in situations where naval forces are alone on the scene, many (and some unique) elements of these functions can and will often have to be provided from space and by long-range, land-based air platforms at longer ranges and with greater sophistication. The JSTARS and TR-1/ASARS functions in providing information about mobile targets on land, many electronic intelligence (ELINT) sensors and EW systems, such as Rivet Joint and Guardrail (CS), and even the airborne warning and control system (AWACS) overland, long-range early warning and battle management functions, are at present unique and will be adaptable for shipboard application only after extensive development time in today's budget environment. All these systems are critical to the new Navy

emphasis on land-oriented warfare, and will contribute to the joint information and battle management system within which the Navy will have to operate.

The Information War Is Crucial

Chart 2.3a Battle Management

- Navy strike and defense need over-the-horizon and close-in capabilities for
  - Surface target location and tracking at sea and ashore
  - Airborne early warning (AEW)
  - EW including sensing and jamming
  - Undersea target location and tracking
  - Non-exploitable combat ID for strike and for defense
- What is in the fleet or furnished from outside determined by
  - Base availability and distance to target complexes
  - Needs for continuity of coverage in time and space
  - Assets available to CINC and needed by battle force commander in joint environment
  - Resources available to furnish integrated systems
- Navy must plan evolution of mix

Currently all the airborne sensors are carried on already-available aircraft types that are anticipated to be operational for many years to come. No new large-sized manned airborne platforms are in development as sensor carriers. The technology of the unmanned aerial vehicle (UAV) has thus far emphasized low-cost, tactically utilitarian vehicles, and such vehicles will continue to be acquired and to be extremely useful. At some future time the use of unmanned very high altitude, very long endurance aircraft as intermediate platforms between spacecraft and low-altitude, short-range UAVs to carry particular sensors and communications relays might confer significant operating advantages for connectivity among fleet and land-based systems. At that point it may be seen as worth the anticipated development costs to acquire such a class of platforms. Probably, in those circumstances, the capability will be joint.

It is clear that although the Navy has traditionally planned to have all its sensor systems and platforms organic to the fleet, the current battle management environment has grown beyond that. The Navy will rely on a

mix of information resources from platforms and sensors within the fleet and those outside the fleet, in space, or on land-based aircraft. Some new platforms will be needed in the fleet, since existing sensor platforms are aging and must be replaced. However, the replacements cannot be planned without consideration of the entire sensor mix, of the resources the mix will require, and of the sources of the necessary systems. The intensified attention to joint battle management requires the Navy to plan the evolution of its future sensor mix and platforms in consideration of the joint environment and the mix of resources within and outside the fleet. Also, the complexity of both the emerging Navy system and the joint system of which it is a part will require continual practice by joint forces in peacetime to ensure that the systems will work in wartime.

The increasing number of sources and kinds of information needed for battle management, and the more rapid movement of battles, increase the amount and complexity of the information that must flow in a given time among the Navy and Marine combat elements, and beyond them to the other services, the CINCs, and National authorities (Chart 2.3b).

The Information War Is Crucial

Chart 2.3b Battle Management

- Connectivity in modern environment demands increased bandwidth and data rates
  - More sensors, more sources, more users, more widely distributed
  - More complex information
  - More exchanges among nodes in battle management system
- Battle management must be joint
  - Data links interoperable among sensors and command nodes across services and various-level headquarters
  - Common mission planning systems with shared data bases
- Navy must exercise dynamic leadership in joint planning and implementation

Modern computing and communications make it possible to transmit information in a variety of forms, from short messages to databases to digitized imagery. The information must be timely—some of it in real

time, some in minutes or hours. To achieve this capability will require increased data rates and more bandwidth. Data links must all be interoperable across service and other agency systems. Navy missions can no longer be planned independently of the missions of other forces operating in the same conflict. Mission planning systems must therefore also be joint, and connectivity must extend between the Navy and the joint mission planning headquarters. Lack of such a system was a significant problem in mission planning during Desert Storm.

Thus far, Navy attention in building the fleet battle management system has been devoted largely to Navy systems. The Navy must now extend its attention in this area both to the functional capabilities needing completion within the Navy and to the connections with other service and agency systems. To ensure that the essential inputs to and connectivity with the fleet are provided, the Navy must take the lead in the joint environment to guide joint planning and implementation of the battle management system in such a way that the Navy's essential needs are met and that it can make maximum contributions to all force operations under the joint commander.

3
Air and Surface Forces: A New Balance—Precision Strike, Focused Defense

PRECISION ATTACK WEAPONS

Precision attack weapons were used in modest numbers in the Southeast Asia war and in much larger numbers in Desert Storm. Their use demonstrated that weapons that can hit and kill targets with high probability enable rapid destruction of difficult emplaced targets, rapid suppression of opposing defenses, rapid neutralization of opposing aviation, early destruction of opposing command and control facilities to disable enemy response capability, and destruction of military targets with minimal collateral damage (Chart 3.1). In fire support on the battlefield as well, precision weapon delivery when urgently needed over a short period in proximity to friendly troops can eliminate opposing fire positions and armor with less risk and less waste of resources and effort than unguided fire. Overall, when total weapon delivery costs including weapon costs, the costs of losses, and the costs of repeat strikes are accounted for, the use of precision weapons is more economical and effective despite the higher costs of the weapons themselves.

These conflicts also demonstrated that some target complexes such as troop concentrations will demand very large, widely distributed tonnage of weapons in single attacks, and that because of uncertain target microstructures, precision greater than hitting the general target area is, if anything, undesirable. Often, as in the case of the attacks on the Republican Guard in Desert Storm, such attacks must be sustained for some time. In such cases the nation's intercontinental bomber capability must come into play. Both these capabilities are available to a regional CINC, and they make up part of the joint force the CINC can bring to bear when necessary.

In a period when great economy of force is needed because of budget and force size restrictions, each component service cannot afford to spend effort and resources striving to perform tasks that can be carried out more effectively by other component services, nor to spend the additional time and casualties entailed in less than the most efficient and effective operations. Moreover, for the Navy with its restricted space in ship magazines, use of precision weaponry whenever possible means that more "target kills" can be carried aboard ship on a given deployment, with less time needed for replenishment during a campaign.

Air and Surface Forces: A New Balance

Chart 3.1 Precision Attack Weapons

- Weapons, sorties, time too scarce to waste on attacks that do not kill targets
  - In all tactical missions from strike to close support
  - Intercontinental bomber force can deliver mass tonnage
- Applies at all levels
  - Long-range (100 to 1,000 nmi) missiles
  - Standoff (5 to 100 nmi) air-delivered weapons
  - Close-in fire support weapons
- All, in total system—targeting through delivery to BDA
- Fleet tactical ballistic missiles and rockets now a viable option
  - For fast time on target at long range
  - For massed fire support to amphibious forces
- Integrated weapon mixes, targeting, and delivery systems remain to be planned

Concentration on precision strike using modern technology will change the traditional approach to land (or sea) attack. The usual pattern has been to locate targets using ship-based reconnaissance assets or forward observers on the ground, and then send aircraft with high tonnages of bombs for attack. In the precision strike mode any of several sources may send target location and identification data to a carrier, a missile ship, or a missile in flight, which will attack with precision guidance against targets from anywhere in the fleet. Attention will be needed to three levels of precision weaponry:

- Long-range (100 to 1,000 nmi) strike missiles (cruise and ballistic, depending on needed range and delivery time), to be used against:
  - Strategic targets (enemy warfighting, sustainability, C^3);
  - Long-range air defenses;
  - Emplaced counters to the fleet and amphibious landings, such as surface-to-surface missile sites;
  - Targets in the enemy's rear that may be stationary for a time but that may imminently threaten friendly units;

- Standoff (5 to 100 nmi) air-delivered weapons, for use against:
  - Emerging, defended threats to the fleet or to friendly shore installations;
  - Air defenses;
  - Critical targets for the field forces; and
- Close-in air- and missile-delivered weapons for close fire support of maneuvering troops.

Development of such weapons can be shared with other services. However, integration of these weapons into the Navy strike system will require that they be used as parts of a total, integrated strike system that includes surveillance, targeting, movement to the targets, combat ID, weapon delivery, escape or protection of the delivery platform from return fire, and damage assessment to enable planning of subsequent weapon delivery. In the past, acquisition of weapons has seldom been undertaken in such an integrated system context; the demands of budget and force efficiency and effectiveness make it mandatory for the future.

Modern technology has led weapon capability to the point that precision attacks from the sea with ballistic missiles, at long as well as short ranges, against mobile as well as stationary targets, have become feasible and in many cases desirable. Although such missiles by the nature of their trajectories and speeds have less range than cruise missiles for a given volume and weight, they can nevertheless be designed to reach distances of many tens and some even hundreds of miles, with useful warheads, within the same missile size "envelope" as Tomahawk-size cruise missiles and their vertical launch bays. If they had appropriate submunition warheads they could strike moving ground forces with significant effect. They would have the great advantage of rapid response (in a few minutes' flying time) to strike targets that can move. Such weapons will constitute a new fleet capability, to be integrated into the fleet as resources allow.

The Navy's current strike capability includes a mixture of weapons and targeting systems accumulated over the years. Many of them still apply in today's environment, but many are reaching the edge of unsuitability to the new mission structure. The Navy must now plan its total future mix of weapons, targeting, and delivery systems suited to the emerging threat conditions and needs and the new force planning and support environment. Advancing technology opens new opportunities, and constraints on new platform acquisition intensify the urgency for meeting this need.

NAVAL/MARINE AVIATION TECHNOLOGY

The rate of acquisition of new aircraft for the Navy and Marine Corps in today's environment is uncertain. However, it is timely to note and take necessary action to adjust to the factors that will drive new aircraft designs, whenever they may be acquired.

Effective use of stealth technology in new combat aircraft designs remains essential. Anti-aircraft systems such as the Russian SA-10, similar to the most advanced U.S. systems, and others, are being spread to all the areas where the Navy and Marines may have to fight. Effective attack air operations over enemy territory will not be possible unless Navy and Marine strike aircraft are able to avoid being engaged while carrying out their missions. Currently, that is done by defense suppression, electronic countermeasures (ECM), and tactics such as flying under the defense envelopes until they can be taken out by weapons such as HARM. Stealth will enhance survivability of combat aircraft and will mitigate the needs for extensive mission support such as escort and self-protection jammers, at the same time adding flexibility to air combat and attack tactics. The impact on total combat aviation system composition can be great enough to make incorporation of stealth technology a major reason for acquiring new attack and fighter aircraft when platforms are renewed. Use of precision strike weapons will ease the design task for stealthy attack aircraft, since fewer weapons need be carried on a sortie and internal carriage of the entire weapon load becomes more feasible.

New radar technology makes it possible to combine functions in a single system. Thus, ground surveillance including moving target indicator (MTI) for vehicle movement and radar imaging of targets is feasible in a single-phased array radar. Airborne early warning (AEW) can also be built into such a system with appropriate beam shaping. The resulting AEW capability would not be optimal, but the advantages of consolidating functions in a single system and platform might well outweigh the penalties, especially in the absence of a long-range threat at sea and in the joint environment when land-based systems will usually be available.

New sensor developments such as these will not be inexpensive, and they will have to be integrated with new or appropriately reconfigured sensor platforms. Those, in turn, will have to be considered as parts of precision strike and defense systems. The Navy faces a need to replace virtually all its platforms in the next decade or so. This will not be feasible in today's budget environment. The question of priorities the Navy must therefore face is the order of replacement of the fleet sensor, combat, and utility aircraft with their combat systems. This priority question must be dealt with in terms of:

• Potential threat advances, projected far into the future (however difficult that may be) to shed light on relative urgency of needed platform changes;

• The total strike and defense system design, including the questions raised above, about the mix of organic fleet capability and external resources, and the strike system composition;

• Adaptations of existing aircraft that might be made to meet the new mission requirements for targeting and precision strike; and

• Service life extension possibilities for the existing aircraft.

Air and Surface Forces: A New Balance

Chart 3.2 Naval/Marine Aviation Technology

- Stealth remains important for strike aircraft survival
  - Opposing air defenses becoming more capable
  - Precision weapons facilitate stealthy strike aircraft design (fewer weapons, internal carriage)
- New sensor and communication technology changes sensor aircraft design parameters and needs
  - For example, single-phased array radar for AEW and surface targeting
  - Smaller crews; processing at distributed surface terminals
- Budget realities will determine sequence and timing
  - Service lives of all aircraft can be extended
  - Precision weapons extend existing combat aviation capability—fewer weapons, longer radius, more target kills per sortie
  - New combat aircraft not justified without stealth
  - Sensor integration can reduce proliferation of sensor aircraft on carriers
- Integrated planning needed that accounts for
  - New threat and joint operating environment
  - Complementarity among space, land-based, and organic information and battle management resources
  - Total target engagement sequences including surveillance, targeting, mission planning, target attack, attack assessment
  - Cost of advanced technology

CHANGED FLEET DEFENSE NEEDS

During the last decade or so of the former Soviet threat, the U.S. surface fleet appeared increasingly vulnerable to improved Soviet counter-ship capability and to such capability being transferred to the Third World. Other countries have sold anti-ship capabilities as well. The capabilities transmitted or sold have included:

- Improved, longer-range sensors and space surveillance;
- Accurate anti-ship missiles having low radar and infrared (IR) signatures;
- Modern non-nuclear submarines with advanced torpedoes;
- Mine warfare, including both old- and new-technology mines that are difficult to counter; and
- Tactical ballistic missiles.

Also, nuclear warheads for such missiles have existed in Russian forces and may appear in other countries' forces before long. Finally, even relatively primitive nations can produce chemical and biological weapons for purposes of disrupting fleet activity and as weapons of terror, and can deliver such weapons by many means.

Spurred by the increasing threats, however, the United States has at least partially developed many counters; some have been or are being incorporated in the fleet, and others remain to be fully developed as the fleet is renewed over the years (Chart 3.3). They include:

- Ship signature and wake reduction;
- Increasingly effective countermeasures to attack weapon targeting and guidance systems;
- Significantly improved anti-air and anti-torpedo defense capability;
- Improved approaches to mine and countermine warfare; and
- Improved passive protection features in addition to signature management, including selective armoring with advanced armors, low probability of intercept (LPI) sensors and communication, and improvements in damage isolation and control capability on ships.

With the diminution of the former Soviet threat and the strengthening of U.S. fleet defense in response to that threat, the U.S. surface fleet has been relieved of the pressure to devote a disproportionately large amount of resources to defense. It finds itself by far the most powerful naval force afloat, with no nation able to challenge it directly. The continuous drive to expand the battle space for the outer air battle that was

spurred by the BACKFIRE threat with its supersonic cruise missiles of continually increasing range, the deep concern about Russian supersonic sea-skimming missiles launched from ever-quieting submarines, and the constant need to keep ahead of a torpedo threat that included wake-homing underkeel torpedoes that can sink the largest ship with one hit, are at least for a time (and perhaps a long time) no longer continually driving fleet expenditures.

Air and Surface Forces: A New Balance

Chart 3.3 Changed Fleet Defense Needs

- Threats against surface fleet much reduced
  - Ever-expanding outer air battle space has shrunk
  - Spurred by former Soviet threat we have devised many ways to defeat more effective individual counter-ship systems
  - Currently foreseen opposition without extensive Soviet-style force integration, much less capable
- But . . . many threats remain and counters require lead time
- Some counters must be pursued now
  - Countermine, ship self defense, ATBM for ports and landing zones, coastal ASW, ship damage control

However, since there are many potentially dangerous threats to the fleet's successful operation, even in the lower-opposition environment, the Navy must be prepared to build the counters. Counters take time. There is a premium on intelligence to learn as early as possible when such threats may be in the offing and their status. Some of the threats are here now, and we know work must either begin or continue on the counters without delay. These include countermine warfare, improved ship self-defense, shallow-water antisubmarine (ASW), anti-tactical ballistic missile (ATBM) capability for ships protecting ports and landing zones, and improved ship damage control to help overcome the political "tyranny of the single hit" described above.

ENHANCED SHIP DEFENSES

Among the most severe threats facing the surface fleet today, because of their wide distribution, are the increasingly capable anti-ship cruise missiles proliferating around the world. The potentially serious impact of such weapons on U.S. fleet operations was shown in the South Atlantic war fought by the United Kingdom, and by the near sinking of the *Stark* in the Persian Gulf. While in the former case the threat was easily defeated after the first hit sank the *Sheffield*, the missiles being sold on the world market have been improved considerably since then. It may be argued that the *Stark* was unprepared for the attack because the Iraqis at that point were supposed to be a neutral or even friendly nation. But such missiles will inevitably be in the hands of any significant and potentially hostile nation we may face in a naval operation, and even if they are not used their presence will enforce a certain "virtual attrition" in diverting forces or inhibiting operations where the weapons *may* be used.

Also proliferating at a rapid rate is the tactical ballistic missile (TBM). While current missile designs having warheads with no terminal guidance would appear to pose no threats to moving ships at sea, addition of terminal seekers and necessary control capability, and building the necessary real-time targeting systems, pose no technical problems that could not be overcome by a determined foe with modest technical capability, especially with technical help from outside if needed. A surprise use of nuclear warheads could overcome the need to do that much. Many means would be available to target a large ship, including neutral-seeming vehicles such as transport aircraft or fishing boats. In addition, the Navy will spend much time in port or near shore and in restricted waters supporting land operations, introducing vulnerable periods when large ships can be attacked even by unguided TBMs. Part of the Navy's mission may include providing ATBM protection to a port or coastal city.

Even though the fleet's defenses have increased to meet many of the threats facing the fleet, those defenses have to be "tuned" to meet the new mission requirements in the newly emphasized operating environment (Chart 3.4). Enhanced fleet defense requires better integration of soft-kill electronic support measures (ESM) and electronic warfare (EW) with hard-kill gun and missile systems; extension of ship self-defense systems to better ensure success against stealthy incoming targets; and upgrading of the AEGIS system and Standard Missile to have an ATBM capability—against unguided incoming warheads initially, and against the more difficult terminally guided, maneuvering warheads in the next phase. Enhanced torpedo defense and improved ship damage control to mitigate the effects of hits must also be pursued. Passive measures, such as positive ventilation and washdown systems, counter-terrorist actions in port, and medical

preparedness, are needed to guard against surprise use of chemical warfare (CW) and biological warfare (BW) against the fleet.

Air and Surface Forces: A New Balance

Chart 3.4 Enhanced Ship Defenses
(Carriers and Battle Force Combatants)

- Integrate hard-kill and soft-kill systems, with cooperative engagement for forces greater than 1 ship
  - Doctrine, tactics, sensors, weapons, EW, connectivity
- Upgrade shipboard missile and gun systems for faster response, engagement of stealthy targets
- Upgrade AEGIS to counter non-maneuvering TBMs (warhead kill); maneuvering warheads, next phase
- Ship torpedo defense—detection, active defense
- Passive measures vs. CW, BW attack

Finally, R&D must continue to maintain the ability to meet more serious threats that may arise in the distant future. Defense systems take a long time to field; the capability to move rapidly into engineering development with a new system is essential to take years off the process.

4
Amphibious Forces: Enhanced Force Projection Ashore; Countermine Critical

AMPHIBIOUS WARFARE

Amphibious forces are a major means for projecting integrated U.S. air-ground warfare capability ashore, especially where conditions preclude timely entry of Army and Air Force units (Chart 4.1). Military opposition to landing of such forces will vary widely. "High-end" opposition by a well-armed opponent, such as the Iraqis were at the outset of Desert Shield/Desert Storm, will be able to orchestrate diverse responses, including rapid reinforcement to contain and attack landing forces. Total surprise in landings will be difficult to achieve, and direct assault against heavy opposition in the World War II mode will be infeasible. These circumstances will induce a redirection of amphibious warfare force design and operations. The changes and advances needed are already in train.

Amphibious Forces: Enhanced Force Projection Ashore; Countermine Critical

Chart 4.1 Amphibious Warfare

- Key means for projecting land-air power ashore
- Much sophisticated opposition; amphibious forces more detectable, more vulnerable
- Forced entry at some level still anticipated
- Important tasks for navy seals
- Two-echelon force:
  - "Spearhead:" stealthy, light, hi-technology
  - More traditional force
- All embedded in combat information network

Amphibious forces will have to be designed over the long run, as resources permit, to land against capable opponents with higher speed from more distant positions and from more dispersed fleet formations than are involved in today's amphibious warfare concepts. The greater standoff will make potential landing areas more difficult for opponents to anticipate and therefore to defend, at least initially, improving the ability to achieve tactical

surprise in amphibious operations. Higher speed and lower signatures will be required for landing forces.

Navy SEALs will play an important role in scouting, identifying, and reducing the capability of defenses in landing zones. Then, two complementary, fleet-based force configurations are visualized. Implementation of these configurations does not have to wait for longer-range, higher-speed landing craft and aviation, and indeed today's Marine force is evolving in the directions described.

The first is a lead-echelon or "spearhead" force that is well integrated with the SEALs to assist in initial, surprise landings; that is light and highly mobile but well equipped with the most advanced technology for calling in sea-based fire support; and that has advanced, lightweight anti-armor, anti-aircraft, and other small-size, high-rate-of-fire weapons to defend itself. Such forces will be able to carry out independent operations whose duration will depend on the fire support and logistic support that can be provided to them in specific circumstances. They will also have the mission of securing defense perimeters of substantial scope into which a second echelon of more conventional amphibious ground and air forces can then move, if appropriate, to take and consolidate strategically important positions.

The more conventional forces will be lighter than they are today, and will be able to take advantage of advanced technology that can protect them, provide heavy organic fire support, and allow them to take the offensive and occupy territory, all without the kind of heavy armor that characterized the ground forces designed to operate in Central Europe. These forces will also be able to operate against "low-end" opposition in much the same manner as today's amphibious forces.

In both cases non-organic fire support, including both rockets and guided missiles, will be provided at long as well as short range by naval forces and evolving combat aviation. Thus, the Marine forces overall will incorporate versatility needed to meet potential opposition that advances in capability.

The amphibious forces will in time use more, and longer-range, V/STOL aircraft than are used today, for all purposes. These may, for example, include the tilt-rotor craft in development today and STOVL fighter/attack aircraft that would replace the current Harrier and F/A-18 force. Attention to signature reduction will be needed for all forces, and the spearhead forces will have to be able to operate in highly stealthy modes. Finally, all the amphibious forces will have to be integrated into the overall combat information and command networks as the latter evolve.

The basic technologies to support the reconfigured amphibious forces are available today, or will be available from the advances of all the service forces in the future. A few, but not many, specialized systems will

be needed to fulfill specific, unique requirements of the amphibious forces, at the special operations, spearhead, and follow-on or main force levels. Emphasis will be needed on mine location and destruction, over-the-beach equipment and transport, and over-the-horizon surveillance systems that can warn the ground forces of impending attacks, including those by ballistic missiles.

MINE COUNTERMEASURES

A 1993 study by the Naval Studies Board, *Mine Countermeasures Technology, Volume I: Overview*, (final report in preparation) shows the steps necessary and the technological opportunities available to meet the mine warfare problem. Foremost among these steps is the recognition and acceptance of the potential severity of the problem and assignment of appropriate priority to dealing with it. That should be reflected in the Navy assignment of highly capable personnel to the mine warfare area and recognition of their status through the promotion mechanism (Chart 4.2). Also, Navy intelligence and operational and R&D resources must be devoted to the problem. Then, countermine capabilities can be built in the fleet.

Amphibious Forces: Enhanced Force Projection Ashore; Countermine Critical

Chart 4.2 Mine Countermeasures

- Recognize importance and emphasize in personnel and command systems
- Give attention to mine warfare intelligence, surveillance, reconnaissance from air, surface, subsurface
- Enhance mine detection and neutralization forces and technology, with emphasis on (but not exclusive attention to) shallow water and beaches
  - — Equip MCM, assault, logistic platforms with GPS
  - — Provide environmental sensor suites for helicopters and surface ships
  - — Both "brute force" and "hi-tech" neutralization means suited to shallow water and surf zones
  - — Possible small MCM SWATH and expendable neutralization vehicle

Many possibilities for countering mines can be visualized—some of them very sophisticated, such as synthetic aperture sonars, superconducting gradiometers, and laser line-scan imagers; and some brute force, such as the use of very large, precision-guided bombs to blast "holes" in surf-zone minefields to open channels for amphibious assaults. Underlying all of the countermeasures is the need to know accurately and within the same geographic grid where discovered mines are, where the mine countermeasures ships, aircraft, and instruments are, and where ships penetrating swept parts of the minefields are. Essential to these purposes is the availability of the GPS system to all Special Operations Forces, ships, aircraft, and submarines that may be involved in clearing and penetrating the minefields. If there has been a technological innovation that can change the nature of countermine warfare, GPS is it, and all Navy activities in this area will benefit from it if GPS is appropriately and universally used.

5
Undersea Forces: Shore Oriented

UNDERSEA WARFARE

Undersea warfare forces including nuclear attack submarines such as the SSN-688 *Los Angeles*-class submarines that make up most of the current force, and the advanced SSN-21 *Seawolf* that will be acquired in small numbers, have been designed to meet the most advanced undersea threat the former Soviet Union faced us with, including the possibility of meeting and defeating the Soviet ballistic missile submarine (SSBN) force at sea. This force is not needed as much for these purposes today, although vigilance against a revival of the threat is in order. However, the attack submarine force is available for duties in accordance with the new strategic demands on our maritime warfare forces (Chart 5.1a).

Undersea Forces: Shore Oriented

Chart 5.1a Undersea Warfare

- New emphasis must be on protecting fleet and shipping, contribution to strike warfare
- Threat less able and focused than former soviet threat, but dangerous in regional warfare
  - Could inflict losses on critical shipping (troops, logistics)
  - Could sink major force combatant—perhaps a CVN
  - Could launch nuclear weapons, source ambiguous
- ASW will continue to be difficult
  - Shallow water and other poor sensing conditions near coasts
  - Advanced non-nuclear submarines not fast but very quiet
  - Need deployable arrays, deployable offboard active systems

The regional submarine threat is growing, with sales of diesel submarines and advanced air-independent, conventionally powered submarines to nations that may be unstable or that may be planning to

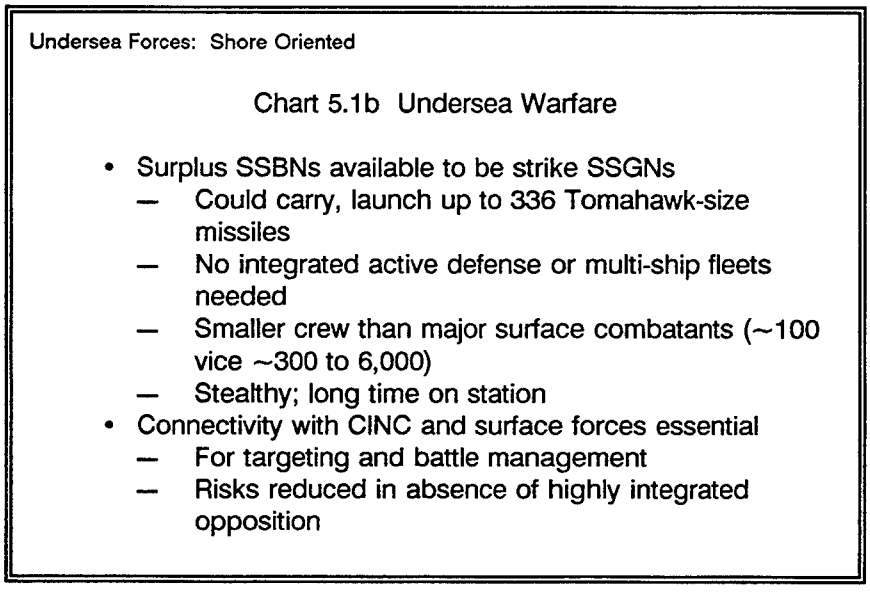
extend their regional power by force. Over 80 such submarines can be expected in the navies of both friendly and potentially opposing developing nations by the turn of the century. While such submarines do not have nearly the capability of SSNs, in range, speed, and endurance and are unlikely to operate within the type of closely integrated command and control that helped to make the Soviet undersea fleet so formidable, they nevertheless pose a serious danger to regional maritime operations by U.S. and allied naval forces. In some ways they might be even more dangerous, because the mutual nuclear deterrence between the superpowers that restrained potential U.S.-Soviet conflict will not be operating.

Opposing submarines can loiter in critical coastal areas, laying mines and sinking shipping. They could launch weapons of mass destruction against cities and installations on shore or fleets in harbor, leaving the source of attack ambiguous. They can attack ships of the fleet, especially when those ships constitute a largely logistic fleet with few warships, as we summoned initially to the waters off Somalia in 1992. There would have been motivation for such attack had the Iraqis continued their advance through Kuwait into Saudi Arabia, with the U.S. response relying on naval forces in the Persian Gulf and the Gulf of Oman. Both cargo ships and warships can be hurt or sunk in such attacks. At some future time Russia may sell its advanced wake-homing torpedoes to a regional power for use with submarines having the right-size torpedo tubes, giving that power the potential capability to severely disable or sink a carrier. While such actions may not stop a campaign, they would subject it to the political "tyranny of the single hit," and could in such a context be very costly to the United States strategically.The U.S. SSN force will have to help protect our shipping and maritime warfare forces against such attacks, and it will have other capabilities and missions important in regional warfare, including offensive action against threatening naval forces, counter-shipping if needed, and strike warfare within joint war plans. Shallow-water antisubmarine (ASW) duties of the submarines and the other ASW systems of the fleet and of shore-based ASW forces will take place under difficult conditions, including very quiet targets in poor sound propagation conditions in the coastal operating areas of concern.

Thus, the main emphasis in undersea warfare will shift to a regime where relatively little attention was given to many of the key elements of the problem in the past, and where R&D and acquisition attention will be needed in the future. This will include shallow-water ASW and active anti-torpedo defense for surface ships. In addition, there are unlikely to be usable prepositioned sensor arrays in the regional operating waters of greatest concern, necessitating development and use of deployable sensors and sensor arrays. Under the conditions expected, active systems will have much to contribute. The deployable arrays will have to include offboard

active acoustic sources that provide signals usable by the submarine and surface ASW forces but that avoid giving away those forces' positions or providing homing signatures.

The size of the SSBN fleet will be reduced under the current and successive START agreements that have been under discussion (Chart 5.1b). With appropriate assurance that conventional guided-missile submarines can be distinguished from strategic nuclear submarines, and assurance that no tactical nuclear weapons are at sea, the SSBNs being retired can be converted to guided-missile submarines (SSGNs). Rather than the 12 or so missiles of the improved SSN 688, a reconfigured SSBN could carry and launch up to 336 Tomahawk-size cruise or tactical ballistic missiles in its launch tubes (2 layers of 7 missiles, each, in each of 24 tubes), adding considerably to the striking power of the fleet. Total force considerations indicate that the submarine would have many advantages.



First, the striking power of such a submarine would be greater than that of any surface combatant as the latter are currently configured. Conversion of the submarine to carry that number of missiles in the existing tubes would be less expensive than augmenting the capability of a surface combatant because of the many changes that would have to be made in the internal arrangements of the surface ship to make room for additional missile bays. The submarine carries a much smaller crew than a major surface combatant—on the order of 100 compared with about 300 in a DDG-51. The submarine is designed for long time on station without

support. Finally, the submarine's stealth makes it essentially invulnerable to detection and attack, so that mutually supporting ships do not have to be sent on the strike mission. All these things taken together suggest that the strike SSGN would be a valuable addition to the fleet in its new mission orientation, and would be very economical for the mission capability it would provide.

For the strike SSGN to be most useful, tactical-level connectivity with the fleet and with the joint commander will have to be provided and maintained, for targeting and for coordination of operations. Such capability in the days of the highly integrated Soviet threat posed vulnerabilities that made sustained tactical connectivity undesirable. In the new environment, without that opposition, such risks in communicating have been reduced, and commanders will be more willing to undertake the diminished risks for the necessary short periods.

6
New Approaches to Managing Technology and People

TECHNOLOGY SOURCES MORE COMPLEX

The nature of the underlying technologies that will drive military capability, highlighted in the original *Navy-21* study, has not changed significantly in the intervening 5 years. However, the applications may be treated quite differently.

In the new environment the Navy and the other services will depend heavily on advances in the civilian sector for underlying technology that may be adapted to military uses (Chart 6.1). In the nature of the interaction between the commercial market system and the military procurement system in a period of declining military investment, the civilian technologies in many areas critical to the advancement of military systems (i.e., computers and communications) will advance much faster than the purely military ones. The military laboratory system and the system of mainly defense- oriented industrial contractors, if they are wisely guided, will concentrate on the militarily unique technologies, and advances in the civilian world will be allowed to guide the rate of technological advance of service systems wherever possible. The military R&D system will, of course, have to see to the adaptation of the civilian technologies to military uses, and it will have to be careful that the adaptation process does not use so much time that the benefit of rapid technological advance in the civilian sector is lost.

New Approaches to Managing Technology and People

Chart 6.1 Technology Sources More Complex

- Many technologies, driven largely by the civilian world, must be adapted to the military, e.g.
  - Information and communication technologies
  - Materials
  - Reduced-cost space launch
- Some military-unique technologies remain, e.g.
  - Signature technologies
  - Sensors, weapon guidance, EW
  - Explosives, propellants, warheads

The fastest-growing areas of technology will continue to be those emerging from solid-state electronics, including electrooptical and opto-electronic systems, associated materials and software and their application to all kinds of computing and communications, and materials applied to fiber optics, aircraft, spacecraft, propulsion, and many other uses. The civilian applications may not lead directly to devices or subsystems such as specialized seekers, radar transmit/receive modules, or other surveillance, guidance, and communication system components needed for maximum overall weapon system performance. However, they will increasingly provide the underlying technology needed for those applications, and will furnish the design and production base that will enable acquisition of small numbers of military items as offshoots from large production runs of civilian items. In particular, since it will be increasingly necessary to control costs of military systems to stay within available budgets, direct applications of civilian products such as chips, computer modules, and other electronic devices should allow simplified designs that are "adequate" to be implemented at much lower cost than the top-performance systems that were driven by the advancing Soviet threat in the past.

Advances in both military and civilian computing, display, and communications technology, including hardware and software, have spurred the recent explosive growth of capability in the simulation area, in all manner of applications from training for astronauts to computer games for children. Appropriate utilization of the capabilities by the DOD can enhance training, and can provide an opportunity for system and operational evaluation in rather general-purpose facilities before extensive engineering development money is spent on systems or operational concepts that may not prove cost-effective after they are implemented. Also, dangerous or complex missions can be rehearsed and refined before actual engagements, thereby increasing the level of troop unit and command-level performance in the engagements. This is but one area of DOD application that will benefit from the infusion of technology derived from civilian life, but a most important one.

In some of the purely military areas, advances will be slower and more judiciously chosen than they were earlier. Thus, for example, stealth and counter-stealth will still be important for military platforms and weapon systems, but wholly new systems embodying the technologies will be slow in coming in times of steeply declining military budgets. Advances in explosives and propellants will achieve more modest levels than the factors of two or more that were thought about in the earlier *Navy-21* report, while warhead and rocket motor designs that can be implemented less expensively will be sought to gain more efficiency and effectiveness from more readily feasible explosives and propellants. Laser and particle-beam R&D to characterize the phenomenology of directed-energy weapons—necessary in

any case—will be pursued at some level, but development of weapons will proceed much more slowly than had been anticipated earlier.

None of this is to say that the military will give up totally on continuing development of systems and technologies for military use. It argues only that in the anticipated future fiscal environment such developments will of necessity be fewer and more carefully chosen.

MANAGING TURNOVER OF TECHNOLOGY

If platform life is to be extended indefinitely, rather than platform generations being continually turned over as in the Cold War period, then several changes in military system design and acquisition will be necessary (Chart 6.2). A corollary to keeping platforms longer is that capability advances in military systems will take place to a great extent through subsystem renewal. The subsystem technology will be derived in large measure from the civilian economy. But the rate of turnover of technology in the civilian economy is much faster than the rate of turnover of applied military technology that is acquired through the military procurement system—for example, 5 years or less for electronic systems in the civilian economy, compared with 10 to 15 or 20 years for military systems. Higher cost goes with the more stringent specifications and extended acquisition cycle of military systems.

The problem of changing the military acquisition system to meet the new conditions faces all the services, so that the entire DOD matériel acquisition system will have to change. Such change will not come easily; it took years to build the acquisition system to where it is now, and that position was driven to a great extent by DOD and congressional concerns for accountability, lack of duplication, and assurance of need before systems or major subsystems are acquired. These concerns are founded in experience, and they remain important in a period when resources must be used even more efficiently than in the past. Reconciling these concerns, all of which have added time to the military acquisition process, with the need to accelerate acquisition to take advantage of the main sources of technological advance will be a difficult process and will take time.

There are steps the Navy can and should take, without waiting for completion of the entire process of change in the acquisition system, to help it use advancing technology effectively as it becomes available:

- All new platforms must be designed with the idea that there will be continual retrofitting of improved minor subsystems, and several major subsystem upgrades during their service lifetimes. This suggests modular design within austere frameworks, to minimize the cost and time of the

changes. It also suggests standard component volumes and interfaces among subsystems and between the subsystems and platform mounts, so that retrofitting does not require major reconstruction of the platforms. Finally, it suggests that comparable subsystems of the different services must be reviewed and accounted for to ensure interoperability and the ability to borrow components from each other to the greatest extent possible. Such interchangeability should be eased by the use of components acquired from the civilian economy.

New Approaches to Managing Technology and People

Chart 6.2 Managing Turnover of Technology

- The United States will gradually change the way military systems are acquired: Navy need not wait
- To keep modern and control costs, Navy must change how new technology is acquired
  - Expect and plan for more frequent subsystem turnover
  - Design new platforms to accept change during their lifetimes
  - Use commercial "testbeds," undertake prototyping, and buy from civilian economy
  - Use simulation to explore military value of new concepts before committing to them
  - Back away from MILSPECs and military system procurement processes; use civilian practices and standards more
  - Limit development by the military to military-unique technologies; adapt civilian product lines more

• In many areas of computing, communication, electronic devices, propulsion systems, and even major platforms there will be civilian, commercial products or the opportunity to adapt military components from commercial products, for use in military applications. Such adaptations have taken place in the past across a wide variety of products, the range of which is exemplified by the Navy Prototype Ocean Surveillance Terminal (POST), which used civilian personal computers as the terminals, and by the KC-10 tanker procured by the Air Force, which used the civilian DC-10 aircraft as its starting point. Clearly, some militarization of systems will be needed in many applications; the problem has often been that full militarization has

been insisted upon when it has not been needed. The levels at which prototyping may be initiated within the Navy (e.g., in the field or at major system commands) should be kept flexible, depending on need and where the ideas are generated for trial, with configuration management introduced at appropriate points in the process.

- Simulation, including the new distributed interactive simulation networks, for testing the military value of many systems and subsystems, and ascertaining how they will be used and whether they are worth acquiring for use in those modes, is a new tool for system design and evaluation. It should be used extensively. Some of the most interesting possibilities in this area are described in connection with personnel-oriented technologies, below. The economic tradeoffs between resource expenditure for simulation and savings on systems that are either revised before "bending metal" or discarded as not interesting after all, will have to be worked out for individual cases, and then as part of general system planning. The important thing is to incorporate the approach into the overall process of specifying, designing, and acquiring new systems and subsystems.
- Similar considerations apply to prototyping of systems before full-scale engineering development. Prototyping whenever possible will show problems that may be encountered and will provide the opportunity to solve them before large expenditures on major developments, thereby reducing technical risk and saving downstream costs. Prototyping would also provide opportunities to test civilian products for suitability and durability, thereby helping the decision about when to incorporate civilian products in military systems.
- The system of military specifications (MILSPECS) should be applied only selectively, and military procurements that "go by the book" should take place mainly in areas where the civilian economy has little or nothing to offer.

The Navy can start movement in the directions described; it has already done so in many instances, and it can pioneer the new processes by setting an example to be followed while it reaps many of their benefits early.

PERSONNEL-ORIENTED TECHNOLOGY

Many improvements in the personnel area can lead to increased operational efficiencies (Chart 6.3). Appropriate attention to selection and assignment procedures can lead to productivity gains for individual crew members in many functions, reflected in reduced personnel aboard ship and availability of personnel for new functions without increasing ships' complements. Changing ships' habitability conditions by using modern

concepts for modular furnishing of living areas, for food preparation, and for service functions like laundry can also mean a reduction in overall personnel aboard ship and more efficient use of the remaining personnel. Attention to human factors in technology development can assist insertion of new technology in ship and aircraft systems without increasing manning requirements. Advances in casualty management can help survival of crew members injured aboard ship or wounded in battle. The advances include such things as new understanding of how to handle casualties when they occur, medical records and personnel identification on chips, and rapid communication with hospitals at sea or ashore to guide treatment of the sick and wounded. All these capabilities are within the current state of the art and need only be applied for their benefits to become available.

New Approaches to Managing Technology and People

Chart 6.3 Personnel-Oriented Technology

- Modernization of personnel utilization and management, and of personnel-oriented systems
  - More effective management of more varied population in uniform (includes more women, minorities)
  - Enhanced productivity
  - Reduced crew size
- Personnel-intensive or dangerous tasks aided by "intelligent machines"
  - Computer-aided diagnostics, repair, logistics
  - Automated ammunition handling
  - Unmanned air and undersea vehicles for reconnaissance, operations
  - Instrumenting ships for damage isolation and condition-based maintenance
- Extensive use of simulation to enhance readiness

Recent advances in the areas of equipment design for ease of use, computer-aided logistic support, automation, and robotic aids to operations can be retrofitted to Navy ships and aircraft. Changes in aircraft, weapon, and C^3I system designs are changing the nature of system support required. Complex electronic systems are designed for more "black box" replacement instead of repair. Automatic and built-in test equipment (ATE and BIT), although it has its own maintenance requirements, is reducing the time

required for fault isolation and repair. Computer-aided logistic support will improve inventory control, reduce spares requirements, and enhance capability for resupply on short notice. Advanced maintenance aids will reduce maintenance time and effort by improved design of systems to be maintained and by rapid fault isolation and ergonomic design of tools and maintenance positions. Computer-based systems can significantly reduce or virtually eliminate the weight and volume taken up by paper records and instruction and service manuals by shifting them to electronic media. Application of composite materials, highly adherent coatings, and non-corroding alloys wherever possible when ships are periodically refitted can reduce preservation and maintenance loads and attending manpower requirements.

There is also significant room for automation of certain critical ship functions, including especially damage control, and ship operations and repair. Because personnel aboard ship have multiple responsibilities, automation can help them considerably, but care must be taken not to reduce efficiency and chances of survival in emergencies. For example, people doing "normal" jobs may be out of position and have to move to new locations for emergency tasks. Automatic closure of routes through bulkheads could hinder this, and either reduce available crew at critical times or place people in danger or in conflict with others, or both. Also, since damage is unpredictable, the opportunity and need to exercise human ingenuity *ad hoc* should not be lost. Other dangerous tasks, such as some aspects of ammunition handling, can be helped by automatic machinery that reduces the exposure of crews to the attendant dangers. Use of unmanned air and undersea vehicles for such tasks as combat reconnaissance and mine clearing represents an extension of such capability off the ship or aircraft and into the combat environment.

The improved knowledge of ship condition and ease of repair resulting from damage control enhancements will obviously also help to increase the efficiency and effectiveness of routine problem isolation and ship maintenance. Automation opportunities, such as instrumenting ships to obtain ship status information and damage isolation, and judicious application of computers and robotics will enable ships' crews to do more effective jobs with fewer people. All the improvements noted can lead to a philosophy of condition-based maintenance rather than maintenance to predetermined time schedules. This, with the application of reduced-maintenance materials and structures, can be expected to reduce maintenance load and therefore crew size and cost.

On-board collective training for combat tasks through use of embedded simulation modes for practice operation of major systems can enhance and maintain crew proficiency during operational deployments. Distributed interactive simulation, at sea or ashore, can help train ships'

crews to operate as parts of a larger force, and can help train commanders in multi-ship, multi-aircraft, and joint operations. It is possible, with networked simulators, to "assemble" on a network many of the critical parts of a weapon system and its connections to the Combat Direction Center, so that a "virtual ship" is created on which officers and men can practice together even though they are physically located in different parts of the country. This can be extended to multi-ship forces, in which some of the participants are actual ships in port or at sea. All such activities will furnish means of enhancing and sustaining readiness, for active forces and reserves.

FORCE EXPANSION FROM RESERVES

All the above changes will enhance the effectiveness of the resource—personnel—on which the Navy will come to depend increasingly for operational effectiveness as budget constraints shrink the Navy's size and new system acquisition opportunities. With or without these improvements, the numbers of personnel in the Navy will shrink. To maintain forces of adequate size for the tasks that will be assigned, the Navy will have to rely increasingly on reserves (Chart 6.4).

New Approaches to Managing Technology and People

Chart 6.4 Force Expansion from Reserves

- Reserves will be increasingly important
  - To fill out thin or cadre crews
  - To add units of particular kind to forces
- Reserve performance highly variable
  - Different for different parts of the service
  - High level of training, skill maintenance essential
- Reserve policies need adjustment to provide flexibility in emergency
  - Call-up of individuals; direct DOD command chain
- Reserve policies, training need revision to utilize reserves effectively for rapid force expansion

Mothballing and reactivating ships and aircraft, and training large numbers of personnel "from scratch," are costly and time-consuming processes, ill-suited to the kinds of contingencies that may face the nation.

Innovative ways of using the reserves will have to be devised. For example, ships may normally be assigned reduced crews who can operate the ships routinely and in situations of low stress. The crews may then be filled out with reserves when they must come to the maximum level of operating strength and capability. Other means may include keeping some ships of a class on reduced operational status with skeleton crews that are augmented by reserves periodically for training, and then for deployment. These examples do not exhaust the possibilities.

The methods of organizing and training the reserves are highly variable with service and with military specialty. Some, such as the air reserves, have often proven to be highly proficient on mobilization. Others have taken considerable training to bring them up to required skill levels, both individual and collective, before they could be committed to action. Also, certain policies, such as mobilization by units, make it more difficult to use reserves in some of the modes sketched above. Chains of command through the states could lead to delays in assigning reserves, and they also affect training and utilization of reserves during training periods.

However the task is done, it will be necessary to train the reserves to higher levels of proficiency with up-to-date equipment of the kind they would use when going into battle, if they are to be useful in rapidly developing crises requiring force expansion in short times. To do this, and to ensure the availability of the equipment when it is needed, the equipment will have to be procured, installed, and operated at some level even on the ships and aircraft considered to be in reserve, and by and for the reserve crews ashore. This will call for different strategies in maintaining and using the reserves than have been customary in prior years. More training time, fixed or mobile training facilities for equipment such as networked simulators, and changed policies of reserve availability and call-up procedures, such as using individual reservists as fillers in existing units rather than calling up reserve units as a whole, will all require changing policies as well as improving available equipment.

The steps called for here will mean higher costs for the reserves than the country has been accustomed to. The total cost of the equivalent force that can be made available in a short time would nevertheless be much less than the cost of maintaining an active force of the same size. If the necessary steps are not taken, then the value of any expenditures on the reserves beyond furnishing a group of not-quite-raw recruits for long-term force expansion, except for those that have been known to be proficient when mobilized, must be questioned. The entire question of the reserves, policies governing their use, and the costs in equipment and training time to ensure their proficiency must be examined by the Navy in light of the new strategic and planning environment.

7
Issues for Urgent Navy Attention

This review has shown that in adapting to the changed strategic and planning environment in all its dimensions, the Navy must study and resolve many issues that will affect its current and future systems and operational modes. Charts 7.1a, 7.1b, and 7.1c summarize the issues identified in this review as requiring urgent Navy attention. All these issues are important, and the order of presentation should not be considered to suggest more than rough priorities. The issues are as follows:

- Initiatives for full Navy participation in joint information acquisition and battle management planning and operation;
- The mix of fleet sensor platforms and systems and those furnished from the outside, including the implications of the mix for carrier aircraft system design and acquisition;

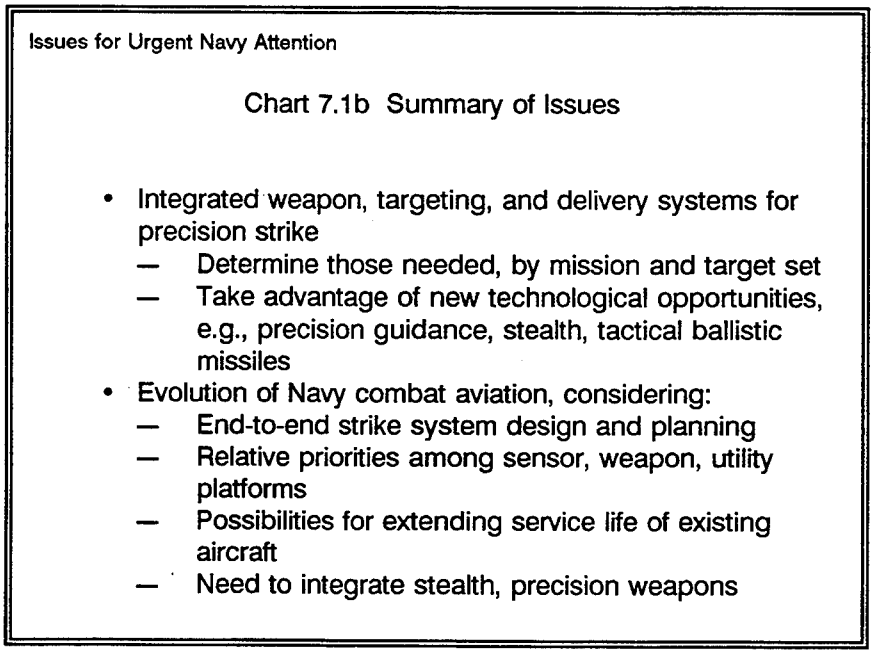
Issues for Urgent Navy Attention

Chart 7.1a Summary of Issues

- Initiatives for full Navy participation in joint "information war" planning and operation
  - Space systems
  - Joint and National intelligence activities
  - Combat information network using all National and service assets
  - Interoperable mission planning and battle management systems
- Mix of fleet sensor platforms and systems and those furnished from outside
  - What organic capability is needed in joint environment?
  - Integrated sensor designs using modern technology, for AEW, targeting, BDA, EW
  - Implications for carrier aircraft design; planning for new aircraft as needed

• Design of integrated weapon, targeting, and delivery systems for precision strike;

• The evolution of the Navy combat aircraft force, considering end-to-end strike system design, relative priorities of sensor and combat aircraft replacement needs, and the need to integrate stealth and precision weapons;



• Planning early defense enhancements for the new environment, including countermine warfare, enhanced ship defenses against stealthy cruise missiles, AEGIS and standard missile (SM) upgrades to meet the ballistic missile threat, coastal-area ASW, and improved ship damage control;

• New policies and procedures for management of technology modernization;

• Revised personnel management, reserve training and equipment, and reserve mobilization policies, to maximize personnel capability and to enable rapid and effective force expansion in an emergency; and

• Planning for conversion of retired SSBNs to SSGNs and their integration into the fleet.

Issues for Urgent Navy Attention

Chart 7.1c Summary of Issues

- Defense enhancements for new environment
  - Countermine warfare
  - Ship self-defense vs. antiship missiles
  - ATBM upgrade for AEGIS
  - Coastal area ASW
  - Ship damage control
- Revised management of technology modernization
- Enhanced personnel management; policy and equipment for reserves
- Conversion of decommissioned SSBNs to SSGNs

List of Acronyms

AEGIS	AEW/Ground Environment Integration System
AEW	Airborne early warning
ASARS	Advanced Synthetic Aperture Radar System
ASW	Antisubmarine warfare
ATBM	Antitactical ballistic missile
AWACS	Airborne Warning and Control System
BDA	Battle damage assessment
BFC	Battle force combatants
BW	Biological warfare
C^3	Command, control, and communications
CINC	Commander-in-chief
CVN	Nuclear-powered aircraft carrier
CW	Chemical warfare
DDG	Guided missile destroyer
DIA	Defense Intelligence Agency
DOD	Department of Defense
ECM	Electronic countermeasures
ELINT	Electronic intelligence
ESM	Electronic support measures
EW	Electronic warfare
GPS	Global Positioning System
I&W	Indications and warning
JCS	Joint chief of staff
JSTARS	Joint Surveillance and Target Attack Radar System
LPI	Low probability of intercept
MCM	Mine countermeasures
MILSPECS	Military specifications
MTI	Moving target indicator
NSA	National Security Agency
OPNAV	Office of the Chief of Naval Operations
RSA	Reconnaissance Support Activity
SAM	Surface-to-air missile
SIGINT	Signal intelligence
SM	Standard missile
SSBN	Nuclear-powered ballistic missile submarine
SSGN	Nuclear-powered guided missile submarine
SSN	Nuclear attack submarines
START	Strategic Arms Reduction Talks
STOVL	Short take-off and vertical landing
TBM	Tactical ballistic missile

UAV	Unmanned aerial vehicle
V/STOL	Vertical/short take-off and landing